FIRST ANNUAL REPORT

ON

THE NOXIOUS INSECTS

OF THE

STATE OF ILLINOIS

BY

BENJ. D. WALSH, M.A.
Acting State Entomologist

FROM
THE APPENDIX TO THE TRANSACTIONS OF THE
ILLINOIS STATE HORTICULTURAL
SOCIETY FOR 1867

SECOND EDITION

PANTAGRAPH
PRINTING AND STATIONERY COMPANY
BLOOMINGTON, ILLINOIS
1903

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The Report of Benjamin Dane Walsh as Acting State Entomologist of Illinois was made under peculiar circumstances, described on pages 5 to 8 of this reprint. At the 26th session of the State Legislature, an act was passed (approved March 25, 1869) "for the relief of the State Entomologist," which had the virtual effect to legalize his acts as a state officer during the period of nearly two years between his nomination by the Governor and his confirmation by the Senate; and his report, made to the State Horticultural Society and not to the Governor, thus became actually, although not nominally, the first report of the office. It was published in 1868, in the Proceedings of the State Horticultural Society (Volume I.) for 1867, and a separate pamphlet edition was printed by the Prairie Farmer Company of Chicago. In both these forms it has long been out of print and has become very scarce. I am pleased to have the opportunity to issue a second edition of this useful and interesting document, to the number of 1,000 copies, and I do not doubt that its republication at state expense is amply warranted by the intrinsic value of its contents, and by its importance as the first of a long series of reports of the official entomologists of this state.

The original edition has been closely followed in this reprint, and no changes whatever have been made except in the correction of a few obvious typographical errors.

S. A. FORBES.

State Laboratory of Natural History,
September 30, 1903.

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INTRODUCTORY.

To Executive Committee of the Illinois State Horticultural Society:

GENTLEMEN:—I present herewith, for publication in your Transactions, my first Annual Report as Acting State Entomologist.

What business I have to assume that title, I may be allowed briefly to explain to the people of Illinois, before I proceed to the discussion of subjects more immediately connected with the Report itself.

The Legislature of Illinois, as you are aware, at the close of the Regular Session in the winter of 1866—7, passed a law which enacts that a State Entomologist shall, by and with the consent of the Senate, be appointed by the Governor, with a salary of $2,000 per annum, and for a period of two years and until his successor is appointed and qualified. Owing probably to the late day at which this Act was passed by the Legislature, (Feb. 27th, 1867,) the Governor made no appointment at this session.

On May 21, 1867—having in a previous resolution requested the Governor to appoint me State Entomologist in order that I might immediately enter upon the duties of that office—you passed the following resolution:

"That the President of the Society be authorized to engage Benj. D. Walsh to immediately commence entomological investigations in relation to horticulture; and be empowered to pay out for that purpose a sum not exceeding $500 from the Legislative appropriation. This action is taken in case of a failure to appoint."

Having been duly notified on May 23d, by the President of your Society, of this most gratifying action on your part, and tendered the full amount of $500 in case I performed the duties specified in the Resolution, I accepted with thanks the offer so liberally made me, in a letter addressed to your President and bearing date May 25th, 1867.

In the meantime the Governor had called a Special Session of the Legislature to meet June 11th, 1867. During this Session he presented my name to the Senate as his appointee for State Entomologist, along with the names of several gentlemen as his appointees on certain political Commissions. In all these cases the Senate took the ground, that they had no constitutional right to act upon such appointments at a Special Session, called for certain specified objects of which such appointments formed no part; and they therefore postponed all further consideration of all these appointments till the next Regular Biennial Session to be held in the winter of 1868—9.

Both you and myself were now manifestly placed in a false position. When the five hundred dollars was voted by you on May 21st, it was known that a Special Session would have to be called some time that year, and it was confidently anticipated by every one, that either myself or some one else would be duly appointed, and confirmed by the Senate as State Entomologist at that Special Session, whenever it met. As the matter actually stood at the close of that Session, neither myself nor any body else had any legal claim either to the title or to the emoluments of State Entomologist; and in the ordinary course of events no one could have such claim for a year and a half thereafter. It was manifestly absurd to suppose, that I could for the sum of $500 perform for two whole years duties, for which the Legislature had thought $4,000 to be a suitable compensation; and the impression on my mind was strong, that the whole movement in this direction had proved a failure and fallen to the ground. All men saw and felt that the Political Commissioners, who had been in the same boat as myself, were politically killed. I supposed therefore that the State Entomologist was entomologically killed.

Feeling as I have stated above, I wrote on June 19th, 1867, to your President, offering to release the Society entirely from any pecuniary claim that I might have on them, and, if they declined such offer, proposing to continue my researches and investigations in the matter of those insects that are peculiarly injurious to fruit, not for the entire period of two years, but for a fair and reasonable time. Your President in his reply, dated July 3d, 1867, declined the former alternative and accepted the latter, generously leaving the amount of labor to be done by me on account of the $500 entirely to my discretion. And here the matter rested for the present; and I went ahead with those investigations, which I had commenced at the end of May and continued up to the receipt of President Baldwin's last letter.

It was my earnest wish to have attended the Meeting of your Society held at South Pass, Sept. 3—5, 1867; but, as will be seen from the following report, several insects—and in particular a very delicate small moth preying on the plum, which was an entirely new discovery of mine, and which will be found figured and described in the Report as "the Plum Moth"—would persist in coming out at that very period; and if I had then left home, almost all my specimens of this moth would have been ruined for want of immediate attention, and the discovery thrown over to be completed in some subsequent year. I had also other investigations in progress which required daily care; and I ventured to flatter myself, that I could do the fruit-growers of Illinois more service by staying at home and

minding my business, than by laying before them in person discoveries only half finished and theories based upon too slender a foundation of facts.

A month later, when the entomological season was nearly closed, I attended the Fair of the State Agricultural Society; and on conversing there with many of our leading Agriculturists and Horticulturists, I found—much to my surprise—that it was the universal opinion among them, that if I went on, fairly and honestly and to the best of my ability discharging the duties of State Entomologist till the next Biennial Session of the Legislature, the Senate would then undoubtedly confirm my appointment by the Governor; and I was strongly urged and advised to take this course by all these gentlemen. I may add that the officers of the State Agricultural Society proposed to me in private, to have the same sum appropriated in my behalf on the part of their Society, which your Society had already appropriated for a similar object. This offer, however, I respectfully but thankfully declined; for I had already made up my mind to go on and discharge the duties of State Entomologist for the whole period of two years for which the appointment was tenable, and to trust to the future liberality of the Legislature to reimburse me for my work.

I therefore, shortly after returning home from the State Fair, took care that the people of Illinois should be informed unofficially through the Public Press of the course that I had determined on; and I further, by the advice of friends, notified the Governor officially of what I proposed to do. I also informed your President, both by letter and personally, that I did not ask any pecuniary assistance whatever for the present from your Society; but that, if the Senate failed to confirm my appointment in the Regular Session of 1868—9, then, and then only, I purposed to call upon your Society for the payment of the sum, which had been so liberally appropriated in the first instance to meet a temporary necessity.

This whole matter is so complicated, and the misunderstandings respecting it have been so general, that I hope that I shall be excused for the publication of all these egotistical details. In justice to the Society, and in justice to myself, I could not well say less; and I have felt throughout, and still feel, a repugnance to thrusting myself forwards—without explanation or apology—to undertake functions, to the performance of which I am not legally and officially called. Time will show whether the people of this great State will endorse and approve what I am doing; or whether I am to be treated as an impudent pretender, who has been assuming a title to which he has no legitimate claim whatever.

The law authorizing the appointment of a State Entomologist makes it one of his duties to prepare an Annual Report of his researches and discoveries, for publication by the State. Under existing circumstances, I have thought that the most appropriate mode of carrying out the spirit, though not the letter, of the law upon this point was to offer this my First Annual Report for Publication in the Transactions of your Society.

In preparing this document, I have aimed to use only such language, as will be intelligible to any one who has had a good Common School education, with one single exception. I have throughout, after giving the English names of insects, added the scientific names, printed in *italics* and enclosed in a parenthesis ( ). The general reader will find the sense always complete without the parenthesis in *italics;* and therefore all that he has to do, in order to avoid those technical names which are so distasteful to many, is to skip over entirely, as he reads on, every parenthesis (printed *in italics*). To the scientific reader the scientific names are absolutely essential, because they are part and parcel of the peculiar language in which he writes and speaks and thinks; and because, while the scientific names are intelligible to every man of science, no matter whether he resides in America, in England, in France, or in Germany, and are the same everywhere throughout the whole civilized world, the English names of insects are often local, and differently employed by different writers and different States. For example:—a minute, two-winged Fly, the orange-colored larva of which infests the ears of wheat in the field a little before harvest, and which is called in English throughout New York and New England "the Wheat Midge" (*Cecidomyia tritici,* Kirby), is called pretty generally out West "the Red Weevil" and often simply "the Weevil," and in Pennsylvania and Maryland is popularly known as "the Milk Weevil." Now, if I have occasion to talk of this insect, and call it, after the fashion of most of our Illinois farmers, "the Red Weevil" or simply "the Weevil," every foreign entomologist, being entirely unacquainted with our local terms, will suppose that I am speaking of some kind of Snout beetle, and probably of that particular little black species (*Sitophilus granarius,* Linnæus), which infests such wheat as is stored in granaries both in this country and in Europe, and is popularly known in England as "the Weevil." But if, on the other hand, I give our popular Illinois name, or the English name used in Pennsylvania, or that used in New York and New England, and add in innocent little parenthesis—☞ (printed *in italics*)—the three words that form its complete scientific designation, then every entomologist, from one end of the world to the other,

knows at a glance exactly what particular species I am speaking of, without the possibility of doubt, misconception, or confusion. Another instance:—I find that an insect, which will be fully treated of hereafter as the "Apple-root Plant-louse" (*Pemphigus pyri*, Fitch), and which, as I have ascertained, is doing an enormous amount of damage throughout our State, destroying apple-trees by what is popularly known as "rotten-roots," is commonly called almost everywhere in Illinois "the Woolly Aphis." Now, if I speak of this insect solely under this name, without adding its scientific name, every foreign entomologist, and a good many American ones besides, will suppose that I am referring to an entirely different kind of Plant-louse which is properly called, both in America and Europe, "the Woolly Aphis" (*Eriosoma lanigera*, Hausmann), and which is as different from the species misnamed "Woolly Aphis" in Illinois, as a sheep is from a goat. Whereas, if I give the scientific name, as well as the English name, every entomologist from San Francisco, in California, to Vienna, in Germany, will know exactly what insect I refer to. Moreover there are already many purely scientific names, which pass current in the mouths of every fruit-grower and even of every farmer. The very name "Aphis," which I have just been referring to as current everywhere in Illinois, is a purely scientific name, and for that reason I have preferred to avoid it throughout in the body of my Report, and to use instead the good old homely Anglo-Saxon word "plant-louse." "Curculio"—which is upon everybody's tongue in Illinois, and alas! also upon everybody's plums and peaches and apples—is another purely scientific word, which has been popularized throughout the length and breadth of the United States, though in scientific language it has a much wider signification than in popular parlance and is equivalent to the pure old English term "Snout-beetle." A third scientific name which has been engrafted into our tongue is "Cantharides," and it is always applied exclusively to a foreign species of the same genus of Blister-beetles, to which belong the old-fashioned Potato-bugs found for time immemorial in Illinois—not the new-fashioned Colorado Potato-bug (*Doryphora 10-lineata*, Say), which only invaded our State a few years ago, for that belongs to an entirely different group. Now, if the general reader can, without the least difficulty, open his mouth wide enough almost every day of his life to say "Aphis" and "Curculio" and "Cantharides," why should he be scandalized, offended and annoyed by *other* scientific names? always provided that they are printed in *italics* by way of a finger-post to warn him off, as we stick up a board with "DANGEROUS" on it, where the ice is likely to break through in a skating-park; and provided fur-

ther that these vicious scientific names are properly fenced in by a parenthesis ( ), so that the incautious traveler may not stumble in upon them unawares, and get his brains kicked out by them before he knows what he is about.

I am well aware that it is impossible to please everybody, and that many men are of a very different opinion from those who take fright at every scientific term, actually holding that nothing can be worth reading, which, as a general rule, is written in such plain and popular language that it can be easily understood. But, because one author writes in a clear and intelligible style, it does not follow that he lacks depth of research and profundity of conception. Because another author indulges in muddy and obscure phraseology, it does not follow that he is a learned man and an original thinker. A puddle is not necessarily deep, because one is unable to see the bottom of it; neither is a lake necessarily shallow because the eye can catch at a single glance every object that exists beneath its pellucid waters. In printed books, we often see ignorant blockheads cover up their lack of knowledge by a string of misapplied long words, as uncalled for as they are distasteful and unintelligible; while the really learned man, instead of going out of his way to lug in technicalities head-and-shoulders, uses them only when they are absolutely necessary to give precision and accuracy to his statements. As a general rule, when an author thinks clearly, he writes clearly; and when an author's ideas are confused, his expressions partake of the disorder of his mental faculties.

In a Memoir intended for publication in the Proceedings of some grave Scientific Society, it would, of course, be highly indecorous to break the dreary monotony of scientific hair-splitting by a single remark, which had the slightest tendency towards exciting that convulsive movement of the midriff, which the vulgar herd of mankind call "laughter." But as this Report is intended chiefly for the use of common folks, who do not think it beneath their dignity to indulge occasionally in a hearty laugh, I hope that I shall be pardoned, if I inadvertently here and there should drop a word, which may cause the cheek of the reader to mantle with a smile. Four hundred years ago Martin Luther said, that "he could see no reason why the Devil should run away with all the good tunes." I can see no reason, in the year of 1867, why the pestilent yellow-covered literature of the day should monopolize all the wit and humor. If there is one thing which I have at heart more than another, it is to popularize Science—to bring her down from the awkward high stilts on which she is ordinarily paraded before the world—to show how sweet and attractive

she is when the frozen crust, in which she is usually enveloped, is thawed away by the warm breath of Nature—and more especially to demonstrate how delightful that particular branch of science, to which I have devoted half a life-time, may be made to any-one, who will keep his eyes wide open as he walks through his garden or his orchard. If I merely succeed in enticing away a single young woman from her mawkish novelettes and romances into the flowery paths of Entomology, or if I can only induce a single young man, instead of haunting saloons and lounging away his time at street-corners, to devote his leisure to studying the wonderful works of the Creator, as exemplified in these tiny miracles of perfection which the people of the United States call "bugs," I shall think that I have not written altogether in vain.

I have felt, of course, that the main object of this Report is, and ought to be, the investigation of the history and habits of such Noxious Insects, as are peculiarly troublesome in the Garden and in the Orchard, and the suggestion of such modes of fighting these foes as will be found to be practically most successful. I know that my principal duty is to add in this manner to the profits of the Gardener and the Fruit-grower, and thereby incidentally to add to the sum total of the wealth of this great and growing State. But "man does not live by bread alone;" and there are other pursuits, besides dollars and cents, which are worthy the notice of every one. It is an excellent thing to have plenty to eat and to drink and to wear, and to have a good warm house over one's head—especially in the winter time in Northern Illinois. These wants of the body are of primary importance, and must be, and ought to be, attended to by every man—whether he be a day laborer, or whether he be a philosopher. But, besides the body, every man has a mind, which requires food, just as much as does the body; and if we starve the mind and feed the body fat, we are simply dwarfing and stunting that intellectual part of us, by which alone we are distinguished from the beasts of the field. I hope I shall be pardoned, therefore, if I occasionally indulge in short digressions, which, though of no immediate bearing upon the main subject of the Report, seem to be calculated to arouse an inquiring spirit in the mind of the reader, and gradually to introduce him to the higher and more attractive and more intellectual departments of Natural History.

Several discoveries in Economic Entomology, made by myself since I became connected with your Society through the action taken by its Executive Board on the 21st of May last, were published at the time in the columns of the now defunct *Practical Entomologist,* of

which I was for the first year of its existence Associate Editor, and for the second year sole editor. These I have not thought it necessary or advisable to reproduce in the following pages, because I have aimed as far as possible to insert nothing here but what is original and hitherto unpublished. On the other hand, certain other subjects have been entirely omitted, because my investigations on those subjects are as yet uncompleted; and others again, because they have reference to insects which are injurious, not to the Gardener and the Fruit-grower, but solely, or almost entirely, to the Farmer.

At some future day—and, if it be possible, by the time that the next Biennial Session of the Legislature takes place—I hope to prepare a General Manual of the chief Noxious Insects of Illinois, comprising all the known facts respecting them that ought to become familiar to the intelligent Farmers and Gardeners and Fruit-growers of this State, no matter whether those facts be already published, or whether they be original. Such a Manual, to be of the greatest practical utility, would require to be very copiously illustrated; but a State, that is wealthy enough to spend three million dollars on a new State-house, ought to be able to afford a few thousand dollars for the publication of a work of primary necessity for nearly nine-tenths of its population.

A few purely scientific descriptions, which it has been requisite to insert in this Report, are printed in smaller type, because they are intended chiefly for the use of the few persons, who may desire to identify scientifically the species therein described. But even these, I have couched, so far as possible, in popular language, occasionally adding the corresponding scientific terms in a parenthis, where perspicuity and precision required it. For instance, if we talk simply of the "jaws" of an insect, an entomologist may be uncertain as to our meaning; for in the typical insect there are *two* pairs of jaws, placed one above the other and called respectively in technical language "the mandibles" and "the maxils." But if we write "jaws" (mandibles)," then everybody will know what we refer to, with just as much accuracy as his peculiar wants may require.

The illustrations furnished herewith have been drawn by myself and engraved by Mr. Wm. Mackwitz, of St. Louis. Whatever defects there may be in them must be laid to my door; for, like everything else which that artist has hitherto executed for me, they are exact and faithful reproductions on wood of the original sketches on paper.

All which is respectfully submitted.

BENJ. D. WALSH, M. A.,

ROCK ISLAND, ILLINOIS, *Dec.* 18, 1867. *Acting State Entomologist.*

INSECTS INJURIOUS TO THE GARDENER AND THE FRUIT-GROWER.

INSECTS INFESTING THE GRAPE.—On the Fruit.

CHAPTER I.—The Grape Curculio. (*Cœliodes inæqualis*, Say.) See plate, fig. 1.

This species of snout beetle was described in the perfect beetle state 36 years ago by the great American entomologist, Thomas Say; but up to this date it has never been recognized scientifically in the larva state, and consequently its habits in that state have remained a sealed book to the great world of science. Yet the destructive operations of the larva upon the cultivated grape have been known to vineyardists for several years back, and the insect appears to be very generally distributed through the valley of the Mississippi; as may be seen at once from the following statements:—

So long ago as 1853, Dr. Warder, the distinguished pomologist, said that "at Cincinnati they have insects that work on the grape—a species of Curculio." (*Transactions Illinois State Agricultural Society,* I. p. 340.) Mr. Spaulding, of Cobden, South Illinois, tells me that he has noticed it on his grapes for four years; and that one particular vine has been nearly ruined by it for three consecutive years. Mr. T. J. Prickett, of the same neighborhood, says that it has infested his grapes for the last three years. One of these years it took, as he informs me, three-fifths of the fruit upon one Isabella and one Concord vine, so as to render the crop almost entirely worthless. Col. H. C. Forbes, of Cobden, finds the Grape Curculio worse than the rot upon his grapes. Mr. S. W. Beckwith, who resides not far from Cobden, discovered five or six individuals of the perfect beetle, which he identified from specimens shown to him by me, upon his grapes, in the forepart of August, 1867. Professor Turner, of Jacksonville, Central Illinois, and Mr. McPike of Alton, South Illinois, both of them told me that their grapes were badly stung in 1867 by what, from their description, must be the same insect. Mr. J. R. Switzer, of Carroll Co. and Mr. W. Olds, of Whiteside Co., both in North Illinois, inform me that they have each of them noticed in their grapes, though only in small numbers, borings which in all probability are nothing else

but those of this Curculio. Mr. C. H. Murray, of Clay City, South Illinois, writes in the *New York Tribune* of October 29, 1867, that "last year nearly all of the wild grapes of that region were stung by some kind of a fly, and at the time of ripening contained a small worm." "This year," he adds, "there are no wild grapes, but the tame grapes have been stung. Some fell off, others remained until the time of ripening, and contained a bluish white worm, about one-fourth of an inch long. Whole bunches of the grapes were thus destroyed, and often every bunch on a vine." Mr. Christ. S. Jackson, of Danville, Kentucky, sent me on July 31, 1867, a large bottle of grapes punctured by this same larva, and some of them still containing the defunct body of the offender. As, however, these grapes were preserved in alcohol, they only enabled me to identify the species, and were useless for the purpose of rearing the perfect beetle. The grapes forwarded by this gentleman were Catawbas, obtained from vineyards at Big Hill, Kentucky, "where," as he adds, "THERE ARE SIXTEEN ACRES IN ONE PLACE ENTIRELY RUINED BY THIS INSECT." Mr. M. C. Read, of Hudson, Ohio, has manifestly, as is proved by a letter of his to me, had his grapes infested for the last three years by this very same larva, though in endeavoring to trace out its Natural History, he has apparently—by a very pardonable oversight in one who is not a professional entomologist—confounded it with one of the leaf-rolling caterpillars of the grape-vine; which last produce, in the perfect state, not a Beetle, but a Moth or "Miller," as it is popularly called. "When my grapes are ripe," so he tells me, "I am compelled to carefully look over every bunch, and pick out the infested berries, before sending them to the table; and out of the eighteen or twenty insects that I have found on the grape, this one gives me the most anxiety. For a slight increase in its numbers would render our grape crop worthless." Finally, my esteemed correspondent, Mr. Joseph Wood, of Marietta, Ohio, informed me last summer that he had "every year hundreds of thousands of grapes punctured by some insect, and afterwards found the larva eating the grape." He subsequently sent me on July 27th, 1867, a box containing a few punctured grapes, two of which had respectively a living and a dead larva in them. Upon examining these larvæ, I was satisfied that they were those of some species or other of Snout-bettle, but that they were decidedly distinct from those of either of the two species—the Plum Curculio and the Plum gouger*—known to infest the plum, with which Mr. Wood had in the first instance confounded them. I therefore wrote at once to him, stating the

*Respecting these two, see below, Chapters XI. and XII.

above facts, and requesting a copious supply of infested grapes. These he obligingly forwarded me in excellent order, and by this means I have been enabled to trace the progress of our newly discovered Grape Curculio from the larva to the perfect beetle state. In the following paragraphs I have, partly from my own observations, partly from the statements of the above-named gentlemen, and partly from certain general laws known to apply to the whole of this pernicious group of insects—the Snout-beetles—drawn up as full a history as possible of this seemingly insignificant, but really very important foe of the grape-grower.

Late in June, or early in July, or a little earlier or later, according to the latitude, berries may be observed coloring very slightly upon one side, as if prematurely ripening. Not long afterwards a dark circular dot may be noticed in the middle of the colored spot, as if a common pin had been thrust red-hot into the berry. The infested berry *does not rot or decay,* but, with the exception of the puncture and the slight discoloration, remains to the last perfectly sound and plump, so far as external appearance goes. Hence the work of the Grape Curculio may be always readily distinguished from the so-called and very appropriately named "Rot," which is caused, not by any insect, but by a microscopically minute fungus. Towards the end of July, if one of these infested berries is cut into, the larva may be generally found burrowing in the flesh and surrounded—as is always the case with the larvæ of Snout-beetles and of Moths—by what is technically termed "frass;" that is to say, solid, hard pellets of excrement, of a round, oval, or short-cylindrical shape, and looking at first sight, like so many grain of gunpowder, their size varying, according to the size of the insect, from that of the finest Sporting Powder to that of the coarsest Cannon Powder. Usually, but not always, the larva gnaws away a part of one of the pips of the grape. As soon as it has got its growth, it drops out of the berry, where up to this time it has kept itself carefully secluded from view, on to the ground, unless, which happens sometimes, the berry has previously fallen to the ground off the bunch—burrows a little distance under the surface—scoops out for itself a small cell in the moist earth by wriggling its body round and round—and there transforms into the pupa state. The pupa I have not seen, but from analogy it must be a whitish or blackish creature, intermediate in robustness between the perfect beetle (fig. 1) and the larva (fig. 1b), incapable of either walking, eating or discharging *fœces,* with rudimentary wings pressed tightly against the side of its body, and with legs and antennæ regularly arranged in a backward direction along its lower surface. The above operations take

place from about the last of July to the fore part of August. About the beginning of September the pupa-shell splits open in front,and the perfect beetle works its way out of the ground, and flies abroad to take its pleasure and enjoy this beautiful green world—which, be it remembered, was made for the benefit of my little friends, the small six-legged Bugs, as well as for that of their more consequential brethren, the Big Bugs with two legs. The sexes then probably couple, and likely enough the males perish, as is known to be the case in several analogous instances; but the females must undoubtedly survive the winter in some snug retreat, sought out by them for this especial purpose. Otherwise it is impossible to account satisfactorily for grapes being punctured by this species of Snout-beetle in the June of the following year. At all events I have repeatedly found dozens of different species of Snout-beetles, very closely allied to the Grape Curculio, snugly ensconced in moss and other such matters in the early spring months, before the universal World of Insects wakes up from its wintry sleep, to hymn the praises of their Great Creator through all the joyous months of summer.

According to Colonel Forbes, of Cobden, Illinois, grapes stung by the Curculio mostly drop from the vine. According to Mr. Murray, of Clay City, South Illinois, as quoted above, some fall off and some remain until the time of ripening. According to Mr. Read, of Hudson, Ohio, large numbers of them hang on the bunch, as we have seen above, until they are ripe. According to Mr. Wood, of Marietta, Ohio, the berry "after awhile drops from the stem, before it is ripe enough to cut, sometimes showing a premature reddening." These slight discrepancies may be readily accounted for by differences either in soil, in climate, in season, or in the variety of grape especially referred to in each of the above cases.

The larva of the Grape Curculio (fig. 1b) is an elongate, legless grub, four or five times as long as wide, nearly cylindrical behind, but tapered in front towards the head. When fully extended, its length is about two-tenths of an inch. The head is large, horny, and of a pale brownish yellow; the jaws (mandibles) are chestnut brown, robust, acutely pointed, and gradually curved inwards; and their general direction in repose is parallel with the axis of the body. Along the upper surface of the skull is a very distinct longitudinal groove or suture. The color of the body is a semi-transparent, yellowish white, with a darker stomach. Each segment of the body bears upon each side a large, fleshy, acutely-pointed tubercle, directed sideways; by which character this larva may be distinguished at once from those either of the Plum Curculio (*Conotrachelus nenuphar*, Herbst) or of the Plum Gouger (*Anthonomus prunicida*, Walsh); and in addition the last or anal segment bears at each of its hind angles a similar tubercle, directed backward.

This larva, though legless, walks readily, and; like those of all other beetles known to me, never uses its head by way of foot to assist its progress, as those of almost all two-winged Midges and Gnats (*Diptera nemocera*) commonly do. Neither does it curl up, belly inwards, in a semicircle, as do the larvæ of many other Snout-beetles, and as does more especially the common White Grub (*Lachnosterna quercina,* Knoch) and its numerous allies. All the specimens seen by me, whether from Ohio or Kentucky, were in green grapes and of a pale color; but Mr. Spaulding, of Cobden, has assured me, that the darker the grape is, the darker the larva becomes.

THE GRAPE CURCULIO. (*Cœliodes inæqualis*, Say.) Fig. 1. Black, with minute, short, scale-like, appressed white hairs, so as to give the black a grayish tint. *Head,* including the beak, punctured almost as coarsely as the thorax; beak reaching a little beyond the base of the middle pair of legs, nearly cylindrical, curved inwards in a circular arc of about 60 degrees, and sometimes tinged with brick-red. *Thorax* with rather large confluent punctures, its sides converging in a convex quadrant for ⅔ of the way from base to tip, thence to the tip converging very gradually in a straight line. Tip of thorax about one-half as wide as its base, and squarely docked with a slight central excavation (emargination); its anterior edge always more or less tinged with brick-red. A transverse impressed line for ¾ of the way from the scutel to the tip of the thorax; and a deeply impressed dorsal longitudinal line, which after crossing the transverse line becomes much fainter. On each side of the deeply impressed part of the dorsal line is a very large rounded tubercle, and outside this, but rather nearer the base, and almost on the lateral edge of the thorax, is a smaller subacute tubercle. Region of the scutel impressed. The *wing-cases (elytra)* are slightly freckled with small gray spots caused by the greater denseness there of the scale-like white hairs; their grooves (*striæ*) are punctate with large, widely separated punctures; and the respective interstices between the 2d and 3d, the 4th and 5th, the 6th and 7th, and the 8th and 9th grooves are wider and, especially the first two, more highly elevated and rounded in front than the others. The *lower surface* of the body is punctured like the thorax, but much more sparsely. The legs are of a more or less dull brick-red, the thighs unarmed, the four front shanks with a large rectangular tooth near their outer base, the hind shanks unarmed. Near the outer tip of each shank a few stiff, short bristles. Length of the body 0.09—0.11 inch.

Described from eleven species, bred September 2d—6th from infested grapes of the same year's growth. Two specimens, captured at large many years ago in Illinois and now in my cabinet, agree in all respects with the others. I had originally referred this species to *Ceuthorhynchus* (*cœliodes*) *curtus*, Say, as it agrees pretty well with Say's description of that insect, after inserting a phrase which has apparently, through some clerical or typographical error, been omitted in the printed editions; for otherwise the word "SMALLER" in Say's description is unmeaning and unintelligible. After inserting the omitted phrase in brackets, Say's description would read as follows: "Each side [of which line is a LARGE rounded tubercle, and outside of this tubercle]rather behind the middle is a SMALLER subacute tubercle." But

Dr. J. L. LeConte, to whom I have forwarded specimens of this insect, has kindly shown me that this species disagrees in several characters with Schoenherr's more full and elaborate description of the *curtus* of Say, which was probably based upon specimens furnished by Say himself. And as, having in his cabinet a species which he considers as the true *curtus* of Say, he prefers referring our species to the *Ceuthorhynchus inæqualis* of Say, I willingly bow to his authority; though there is the great objection that *inæqualis* is described as "brown" by Say, and this species is most decidedly not brown but black. The size given by Say for *inæqualis* (over 0.10 inch) certainly agrees much better with the *average* size of this species, than the size which he assigns to *curtus* (under 0.10 inch). But, as I have one specimen of this species only 0.09 inch long, and as Say, like too many other entomologists, scarcely ever gives the number of specimens used by him in describing, it is impossible to be certain that he did not describe from a single unusually small specimen. After all, both of these two descriptions of Say's, like the great majority of those that we have to work on in entomology, are so brief and defective, that to determine to which of the two species the Grape Curculio belongs, or whether it really belongs to either of them, is a mere scientific conundrum.

In such a case, the best way is to allow the leading Coleopterist of the country to decide the question, and abide by his decision, so as to avoid confusion and the multiplication of synonyms—that curse of descriptive entomology. At all events, I think that the Grape Curculio is now so fully and precisely described that—no matter what scientific name we may decide to give it—it can never hereafter be mistaken for any other species. So much for this entomological riddle, to solve which with certainty would require a Guessing-machine of 1,000 Yankee power.

In the perfect Beetle state the Grape Curculio will not be easily identified by the inexperienced in such matters, owing to the obscureness of its coloring, the absence of any conspicuous markings, and the fact that many perfectly distinct species—several of which, however, have a characteristic white scutel—resemble it strongly at first sight. But almost all of these last, though they have the same general appearance as the Grape Curculio, yet belong to different genera, the described North American species of the genus (*Cœliodes*) being very few in number. Hence our species may be recognized with tolerable certainty by a remarkable character, peculiar to the genus (*Cœliodes*) and not found in the allied genera (*Phytobius, Ceuthorhynchus, Mononychus, Copturus,* etc.); namely, the rectangular thorn or tooth on the upper and outer edge of the four front shanks (*tibiæ*). For convenience' sake, a greatly magnified figure of the front leg is given in figure 1a, where the reader will see at a glance the nature of this distinctive character. The bristles near the tip of the shank are in nature sometimes obliquely erected, as shown in the engraving, sometimes depressed so as to be almost invisible except under a lens of very high power; some of the legs in one and the same specimen often

having the bristles erect, and others having them depressed. At first sight I supposed that these bristles were a sexual character.

I have shown at great length, in my Papers on Willow-gall Insects, published in the *Proceedings of the Entomological Society of Philadelphia,* that, in the case of many larvæ dwelling in the interior of vegetable substances, and deriving their food from such substances, there are what may be called "Guest-larvæ," belonging to distinct Species, and often to distinct Genera, to distinct Families, and even to distinct Orders of Insects. These last take advantage of the tenement prepared for them by the original inhabitant, who thus becomes their Host, and feed conjointly with him upon the same vegetable food. Technically, such insects are called "Inquilines;" but until I published on the subject, entomologists were not aware how extensively this system prevails throughout the world of insects. From the "Parasites," properly so called, these "Inquilines," or "Guests," as we may call them in English, differ very widely, in that they are normally vegetable feeders, and only occasionally or incidentally destroy the life of their unfortunate Hosts; whereas the true "Parasites" feed exclusively upon the living bodies of their insect victims, and with a few exceptions live inside those living bodies, devouring the flesh piecemeal, although some few of them attach themselves externally to their prey, and gradually suck its life away like so many miniature leeches.* These last, by the way, must not be confounded with what I have called "Cannibal" insects; for each of these externally-feeding Parasitical larvæ attaches itself to a single victim, which it never quits till it has attained its full growth, whereas the true Cannibal larva roams hither and thither, and before it attains its full growth will probably have devoured dozens of victims. Hence, by a beautiful provision of nature, all the Parasitical larvæ, whether internal or external feeders, are legless, because they have no occasion for locomotion; whereas all Cannibal larvæ, inasmuch as they require to move from place to place, are furnished with legs, and are usually pretty strong on the leg besides. In two words—to return to our new friends, the Guest-larvæ—the difference between the Guest-larvæ on the one hand and the Parasitical larvæ and Cannibal larvæ on the other hand, is pretty nearly that between an American burglar on the one hand and a Polynesian cannibal on the other hand. The insect Guest and the human burglar desire the goods of their victims and do not usually take their lives, unless, for the object that they

*I have ascertained that a number of larvæ belonging to the *Chalcis* family have this peculiar habit, and among the *Ichneumon flies* the genus *Ophion* has long been known to feed externally in the larva state.

have in view, it is necessary or convenient to do so. On the other hand the insect Parasite, and the insect Cannibal and the human cannibal desire the bodies of their victims as food for themselves, and are necessarily obliged to slay, because it is only by inflicting death upon others that they can satiate their own carnivorous appetites.

In the case of the Grape Curculio, as in many other such cases, there is more than one species of Guests sponging upon a single Host. I find that two very distinct larvæ—one of them belonging to the same Order as the Curculio, (the *Coleoptera* or beetles,) but to a very widely distinct Family, the other to an entirely different Order (the *Diptera* or Two-winged Flies)—occupy the grapes after they have been tenanted by the Curculio, and derive their subsistence therefrom. Whether these spongers upon the fruits of other Bugs' labors dwell as co-tenants with them in the larva state, I do not know. Perhaps they do not; at all events they do not do so for any considerable time. But most certainly the eggs, from which the intruding guests spring, must be deposited in the infested grape by the mother-insect before the larva of the Curculio leaves it; for my infested grapes contained the Curculio larvæ when I received them from Ohio, and were thereafter isolated in a closed vase, to which the mother of the Guest-larvæ could gain no possible access. As one species of these guests arrived at the perfect state about six weeks, and the other about eleven weeks after the Host, it is likely enough that the eggs of both of them were deposited in the wounded grape, not very long before the larva of the Grape Curculio was ready to descend to the earth and leave a clear stage for the operations of his successors; and that consequently these eggs did not hatch out till about the time that the spoiled grape was vacated by its original tenant.

The former of the two Guests just now referred to is the Twin-spotted Nitidula (*Stelidota geminata,* Say)—a flattish, oval beetle, of an obscure brown color with dull yellow markings, and rather less than one-tenth of an inch long. It belongs to a somewhat extensive group (the *Nitidula* family), all of which feed in the larva state upon decaying animal or vegetable substances, and several of which may be often met with in decaying cheese, old half-picked bones, old sheep-pelts, etc. Of this insect, from some fifty infested grapes, I bred October 12th—20th no less than thirty-three specimens. So that manifestly their occurring in such grapes was not a mere casual phenomenon, but part of the regularly pre-ordained system of Nature. Nature, indeed, in whatever direction we turn our eyes, is always economizing and utilizing what would otherwise be uselessly expended, and she cries aloud everywhere to those who know how to

interpret her sacred mysteries, that nothing shall go to waste, nothing be lost, nothing be created in vain, whether in the animal or in the vegetable kingdom; and that even death and decay and corruption shall, by her holy alchemy be transmuted everywhere, in the most bountiful profusion, into life and health and happiness.

The second of the two Guests is a species of Midge, belonging to the genus *Sciara* and to the same group of Two-winged Flies as the notorious Wheat Midge, commonly known in Illinois as "the Red Weevil," (*Cecidomyia tritici*, Kirby), and the equally notorious Hessian Fly (*Cecidomyia destructor*, Say). We may call it in English "the Grape Midge." It is a small, slender, long-legged, blackish Fly, measuring to the tips of its wings about one-tenth of an inch, and with no conspicuous markings whatever. The genus to which it belongs is a rather extensive one, no less than *seven* U. S. species (not *three* as incorrectly stated by Dr. Fitch, *N. Y. Rep.* I. p. 255) having been described by a single author, Thos. Say; and moreover the species are difficult to distinguish from one another, owing to the monotonous uniformity of their coloration.* I think that my grape-inhabiting species is probably identical with the Fickle Midge (*Sciara* [*molobrus*] *inconstans*) of Dr. Fitch, which is described by him as making its appearance at the same unseasonable time of the year—the latter part of December—and as running about in the same fickle, rapid, restless manner as I have observed mine to do. Of this Guest-fly, from the same lot of about fifty infested grapes from which I had previously bred the Grape Curculio and the Guest-beetle, I obtained November 19th—29th, no less than thirty-five specimens; and probably,

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*Having found the descriptions of Say's seven species and Fitch's five species of this genus very unsatisfactory, and being unable to separate into distinct species scores of specimens which I had captured at different times, though, by way of guide, I had, besides the "Grape Midge," considerable numbers of two distinct species which I had formerly bred from larvæ found in decaying wood, I sent specimens of the "Grape Midge" to our great N. A. Dipterist, Baron Osten-Sacken, with a request that he would, if possible, determine the species to which it rightfully belonged. For the benefit of young entomologists, I give his reply in this note, without making any alteration in my text. He had previously expressed to me the same opinions with regard to the allied genus *Ceratopogon*, and I have myself published nearly the same views with reference to another allied genus, *Cecidomyia*.

"Your fly is certainly *Sciara*, but the species is indeterminable. I would not give anything for the determination even of a European *Sciara*. It is a difficult genus which has never been satisfactorily studied. The number of species seems to be very large, their coloring uniform, and their characteristic marks unknown. One does not know what to take hold of in describing such a species."

owing to their lively movements, about as many more escaped out of the breeding vase, when from time to time I opened it in order to catch them. As to their habitually living in these infested grapes, the observations already made with regard to the Guest-beetle apply with two-fold force, inasmuch as they were about twice as numerous as the Guest-beetle.

It is worthy of remark, as illustrating what I have called the "Unity of Habits" in the same genus of insects, that another species of the same genus, the Apple Midge (*Sciara* [*molobrus*] *mali,* Fitch) was found by Dr. Fitch to be a Guest in apples infested by the common Apple-worm (*Carpocapsa pomonella,* Linnæus), and to appear in the winged state at the same inclement period of the year as my Grape Midge, namely in February.

Fruit-growers must observe carefully the important practical point, that NONE OF THESE GUESTS DO THEM ANY HARM. It is the Grape Curculio, for example, that in the first instance attacks the berry; and after the berry for all practical uses is ruined, the Guests merely pick up the stray crumbs that fall from the Curculio's table, and clear away from off the face of the earth decaying vegetable matter, that would otherwise become putrid, unwholesome and offensive. To make war upon the Guests would therefore be as irrational, as for a sheep-grower to shoot the turkey-buzzards that are feeding upon the dead carcasses of his sheep, and overlook the blood-thirsty curs that in the darkness of night had carried death and destruction among his flocks.

Nothing is more common among young entomologists than to jump to the conclusion that, merely because they breed a certain insect from some vegetable organism which has manifestly been destroyed by insects, therefore the bred insect is the author of the mischief. No mode of reasoning can be more unsafe and unsound. The bred insect may be, and very frequently is, a Guest; and the Host, who is the real guilty party, may be entirely unknown to them. Or, what is still more common, the bred insect may be a Parasite, feeding upon the body of some unknown species that had originated the damage, and consequently not our foe but our friend. To solve satisfactorily such questions as these, requires careful and long-continued observation and experiment, and an extensive familiarity with the habits and peculiarities of insects. And even then the very best and most careful entomologists will sometimes be led into error. For, although it is a very general rule that species belonging to the same Family of Insects have the same general habits, yet every now and then certain remarkable exceptions to the rule are brought to light.

For example, I have myself bred almost a hundred different species belonging to the great *Chalcis* family (Order *Hymenoptera*), which I know to be parasites; and hundreds of others peculiar to Europe have been ascertained by European entomologists to be also parasitical in their habits. Hence it was supposed formerly that all *Chalcis* flies without exception were parasites. But there is now no doubt that, as Dr. Fitch asserted long ago, the true author of what is known as "joint-worm" in Virginia wheat and in Massachusetts and New York barley is a veritable Chalcis fly. So that in reality, although the great *Chalcis* family is almost universally carnivorous in its habits, it yet contains at least one species which feeds exclusively upon living vegetable matter.

To return to the Grape Curculio. The practical question still remains to be discussed, "How are we to get rid of it?" I think that, beyond all question, the mother-beetle, if carefully looked for, will be found laying her eggs in the young grapes some time in June. From the accurate figure given herewith, and from what has been already said, the species may, I think, be recognized with ease by the vineyardist; though, after it has fallen to the ground, it will hide its beak in the groove along its breast expressly provided by nature to receive that very organ, and fold up its legs so close to its body, that it looks exactly like a round, black seed. In this position, as it "plays 'possum" and shams dead for a minute or two after it has fallen, it would never be suspected of being a living animal by the unwarned and inexperienced. The Grape Curculio should therefore, in localities where its evil works have been already noticed in preceding years, be watched for in June; and as soon as it appears, shaken off the vines upon a white cloth, or—what will be found perhaps still more convenient—into something like an inverted umbrella, lined with white cloth, but modified in shape so as to suit the mode of training the vines which may in each case be practised. The least touch will fetch them off the vines; for this whole group of roundish Snout-beetles (genus *Ceuthorhynchus* and its allies) drop to the earth when alarmed more readily even than the Plum Curculio. Indeed, I have repeatedly observed that they will often drop as soon as they see you looking at them, although the plant on which they are sitting be not touched at all.

The Grape-grower will perhaps exclaim that the woods must be full of this Grape Curculio, and that it will be no use killing a few scores of them off his grapevines, because myriads of others will fly in upon him from the forest. I can assure him that this is not so. The Grape Curculio is comparatively a rare insect, though, like many other

rare insects, nature occasionally concentrates it in considerable numbers for a particular object upon a particular point, i. e., the fruit-bearing grapevine. For ten years I have been collecting insects in various parts of Illinois. I have in that time beaten into my net thousands of wild grapevines, to say nothing of forest trees growing in their immediate neighborhood. Yet in all those ten years I never captured but two poor solitary specimens of my newly-discovered little friend, the Grape Curculio. Moreover, Dr. J. L. LeConte tells me that, until I supplied him with some additional specimens, he had but two representatives of this species in his whole collection of N. A. Beetles, which, so far as regards the number of species, is well known to be the most extensive of any in the country.

It is, indeed, undoubtedly true that, if a vineyardist is surrounded by other grape-growers and all their vines are infested by this Curculio, it will be comparatively but little use for him to destroy the Curculio upon his own vines, unless he can also persuade his neighbors to do the same. For his little black enemy has got good long black wings of his own, and can fly with ease from one vineyard to another, although undoubtedly he is not by any means as strong on the wing and as fond of flying as a Bee or a Butterfly. Still, this only proves the absolute necessity of fruit-growers becoming familiar with the habits of their insect foes, and of their making war upon them systematically and generally. For attaining these two objects, nothing can be more practically useful, than those organized Associations of practical and intelligent fruit-growers, which are now happily becoming so common in all the great fruit-growing regions of the United States.

INSECTS INFESTING THE GRAPE—On the Leaf.

CHAPTER II.—The Grape-leaf Gall-louse. (*Dactylosphæra* vitifoliæ*, Fitch.)

This is the insect which Dr. Fitch described long ago under the above specific name, though it most certainly does not belong to the genus of Plant-lice (*Pemphigus*) to which he referred it, nor even, in my opinion, to the Plant-louse Family, but rather to the Bark-lice. It causes on the lower surface of the leaves of the grapevine immense

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*The genus, *Dactylosphæra* was proposed by Dr. H. Shimer, of Mt. Carroll, Illinois, in a short Paper, published in *Proc. Acad. Nat. Sc.*, Jan., 1867, pp. 1—9. I adopt this generic name, simply because the group of insects to which this species belongs, forms, in my opinion, a very distinct and a very anomalous genus of the Bark-louse (*Coccus*) Family, and there is no other name for it extant. Why this genus of Insects ought to be referred to the Bark-

numbers of green, fleshy excrescences, about the size of a small pea. I was the first to observe, in the columns of the *Practical Entomologist,* that it does not attack indiscriminately all our native and cultivated grapevines, but is peculiar to the Frost Grape (*Vitis cordifolia*) and to a small number of our cultivated varieties, namely, the Clinton, the Delaware, and, according to Mr. George Husmann, of Missouri, the Taylor. Dr. Morse, of Missouri, who has had great experience with the grape, confirms the truth of the above assertion, and informs me that in Missouri the Delawares are sometimes covered with these galls so as to injure them greatly, and that he has occasionally seen a few of these galls even on the Iona vine, which, according to Mr. William Saunders, is a variety of the Northern Fox Grape (*Vitis labrusca.*) One of my correspondents has informed me that a whole vineyard of Clintons near Bloomington, in Central Illinois, was destroyed by this insect in 1866; and it is undoubtedly this variety of the cultivated grape that is the most subject of any to its attacks. Even at such a remote point as Clinton County, in the Northwest corner of Missouri, the Clintons are reported as "not doing well" on account of their leaves being covered with these galls. (*Agricultural Report Missouri, Appendix,* p. 135—6.) What is very remarkable, and well illustrates how certain species of insects swarm periodically and then are not

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louse (*Coccus*) Family, rather than to the Plant-louse (*Aphis*) Family, I long ago explained. (See *Pract. Entom.* II., p. 19, and *Proc. Ent. Soc. Phil.* VI., pp. 283—4, notes.)

To this new genus of his, Dr. Shimer refers, not only the insect which forms the subject of this chapter, but also a mythical and entirely imaginary species—*Dact. globosa,* Shimer— which he has concocted by taking the wingless individuals of the Bark-louse of a very small Hickory-gall (*Caryæ semen,* Walsh MS., *Proc. Ent. Soc. Phil.,* VI., p. 283,) and the winged individuals of the Plant-louse of a much larger and very distinct Hickory-gall (*Caryæ-globuli,* Walsh, *ibid.* I., p. 309,) and assuming, *without a particle of proof,* that the latter are the winged males of the species to which the wingless females of the former appertain. And yet, even according to his own account, (p. 2,) the galls containing these so-called males are "0.25 inch, and even more, in diameter," while the galls containing the wingless females are according to him, only "0.09—0.14 inch" in diameter, and, in reality, are still smaller than he represents them to be, ranging from 0.06 to 0.10 inch in diameter; and, moreover, as will be shown below, the two galls differ by a very remarkable structural character. It is a very suggestive fact, too, that the large galls, containing the so-called males, occur abundantly and commonly on the Shellbark Hickory and but in small numbers and rarely on the Pignut Hickory; while the galls containing the so-called females of what is supposed to be the same species occur exclusively on the Pignut Hickory, and in the most exuberant profusion. Whereas, if these two galls appertained to the same species of insect, on whatever species of Hickory one of

heard of for years:—Although in 1866 these leaf-galls covered the leaves of the wild Frost Grape and of the cultivated Clinton near Rock Island, Illinois, and, so far as I could hear, throughout the State, yet in 1867 on the most diligent search not a single one was to be found, even on vines which had swarmed with them in the preceding year.

Previous to what I published on the subject, authors had always supposed that this Gall-louse attacked indiscriminately all kinds of grape-vines. I was led to remark that it was not so, because I had discovered it to be a general, though by no means a universal rule, both with Plant-lice (*Aphis* family) and with Bark-lice (*Coccus* family,) that the same species of insect is confined to the same species of plant. Even when a species, belonging to one of these two families of insects, inhabits promiscuously two or more species of plants, these plants will usually be found to belong to the same botanical Genus, and invariably to the same botanical Family. We shall meet with another illustration of the practical importance of attending to this law of nature, when we discuss the history and habits of the Apple-root Plant-louse in chapter 10.

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them was found, the other one would be found there also, and, in all probability, always in the same relative proportion.

If any one doubts the validity of the above statement, he has but to refer to the figure of the wings of the so-called male *Dact. vitifoliæ*, in Dr. Shimer's Paper (fig. D, page 1); and he will see at once that it displays the unmistakable wing-neuration of the genus of Plant-lice which Dr. Fitch considered as probably identical with the European genus *Phylloxera*, (see my fig. of it, *Proc. Ent. Soc., Phil.*, I., p. 297, fig. 8)—which I have since proposed to name *Xerophylla* (*ibid.* VI., pp. 282—3, note) and to which the Plant-louse of my *Caryæ globuli* gall belongs. This figure of Dr. Shimer's, it may be added, is totally unlike a drawing of the wings of the veritable male *Dact. vitifoliæ*, which was kindly executed for me by Mr. Cresson, from specimens presented to the Entomological Society of Philadelphia by Dr. Shimer himself, and which drawing I sometime ago communicated to Baron Osten-Sacken. For, in this last, the neuration of the front wing is almost exactly identical with that of a male Bark-louse (see Westw. *Introd.*, II., p. 443, fig. 7), and the hind wing lacks entirely on its front margin the characteristic hook to fasten on to the hind edge of the front wing, which is found in all the genera of Plant-lice with which I am acquainted. Dr. Shimer, indeed, lays great stress upon the absolute necessity of such drawings being executed from the living or recent insect. (Page 5, note.) So far as regards the *body* of the insect, this is true enough; but every entomologist knows, that the *wings* of any insect can be drawn just as accurately from the dried as from the recent specimen.

With similarly unfortunate results, this same author has recently re-described and re-named, as *Hamamelistes cornu*, a gall-making Plant-louse (*Hormaphis hamamelidis*, Fitch), which had been already named and de-

Mr. William Saunders, in an excellent article on the Mildew of the Grape, has asserted that the Delaware is a hybrid between the Northern Fox Grape and the Summer Grape (*Vitis æstivalis.*)* If a bug-man may venture to dispute the opinion of a plant-man, I should infer that as neither of the above two wild grapes are subject to these leaf-galls, so far as I know and as the Frost Grape notoriously is, the Delaware, which I have found to bear these leaf-galls only to a limited extent, is a hybrid between the Northern Fox Grape and the Frost Grape. Certainly its botanical characters seem to me to be intermediate between these two species.

The practical lesson to be drawn from the above theory is, that where two varieties of cultivated grape are in other respects equally desirable, and equally suited to the soil and climate of the vineyardist—say, for instance, the Clinton and the Concord—the Concord should be preferred, because, being a variety of the Northern Fox

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scribed twice over many years before he wrote—namely, once in 1851 by Fitch, and once in 1861 by Osten-Sacken—and to receive which Osten-Sacken had very properly founded the genus *Hormaphis*, of which Dr. Shimer's so-called new genus *Hamamelistes* is a mere synonym. It is very true that we are all of us liable to such oversights, when the book in which a supposed new species has been already described is out of print, or very rare, or only to be met with in foreign countries. But, in this particular case, all the details, which prove the above facts, were collected together and published by myself eleven months before Dr. Shimer himself published, *and in the very work in which he himself published*, which can be procured by any one, with the greatest ease, by paying the very moderate price demanded for it. (Compare my Paper, *Proc. Ent. Soc., Phil.*, VI., p. 281 and Dr. Shimer's Paper, *Trans. Am. Ent. Soc.*, I., pp. 283—4.)

In order to clear away as much as possible the mystery in which Dr. Shimer has enveloped this very interesting subject, I annex, from my Journal, a full account of the Bark-louse Hickory-gall, which I had referred to, as quoted above, under the MS. name of *Caryæ semen.* I am now acquainted in all, besides the Grape-leaf gall *Vitifoliæ*, Fitch, with three very distinct galls on the Hickory, all apparently formed by this same genus of Bark-lice (*Dactylosphæra*); namely, *Caryæ semen*, new species on the Pignut Hickory, (*Carya glabra;*) *Caryævenæ*, Fitch, on the Shellbark Hickory, (*Carya alba;*) and an undescribed species, *Caryæ fallax*, Walsh MS., with a strong external resemblance to the Plant-louse Hickory-gall, *Caryæfoliæ*, Fitch, but opening, not above, as is always the case with that gall, but invariably below. This last gall I found June 17th—29th, 1867, absolutely swarming on the leaves of a bush of the Shellbark Hickory. In none of these three Hickory-galls, though I have opened hundreds of each of them, have I ever yet met with the winged males; and in the Grape-leaf gall the males are equally scarce.

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*Mr. Saunders' article may be found in the *Monthly Report of the Agricultural Department*, 1867, p. 333.

Grape, it never bears these leaf-galls, any more than the wild species from which it took its origin; while the Clinton, being a variety of the Frost Grape, is often grievously afflicted with them, like the source from which it sprang.

CHAPTER III.—The Rose-bug. (*Macrodactylus subspinosus*, Linnæus.)

In particular seasons, as is well known, and in particular localities, this insect occurs in prodigious swarms, and gathers upon grapevines so as to strip them almost entirely of their leaves. The only known remedy that is practically available, is to jar them off the vines and kill them; and of course, if we can induce them to concentrate their forces upon one particular vine and leave the rest alone, the labor of destroying them will be very greatly diminished.

Luckily for the grape-grower, this can be done. There is concurrent evidence from a great number of different sources, that the Rose-bug prefers the Clinton to all other cultivated varieties, and

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Gall Caryae semen, new species, made by *Dactylosphæra caryæ-semen*, new species. On the general surface of the leaflets of the Pignut Hickory (*Carya glabra*,) in prodigious abundance, a subglobular, smooth, seed-like, hollow, sessile gall, 0.06—0.10 inch in its widest diameter, sub-hemispherical above, rather flatter below, with a nipple-like opening in the middle. Walls of the gall rather stout, fleshy and not woody. The external color is greenish yellow above, and pale green below, with the open central nipple whitish. There are frequently as many as one hundred of these galls on a single leaflet. Inside may often be found as many as three or four mother bark-lice, similarly shaped, and of the same yellow color as those of the *Vitifoliæ* gall, but, on the average, rather smaller, and accompanied in the same manner by eggs or very young larvæ, or both. As with the mother bark-lice of the galls *Vitifoliæ* Fitch, *Caryævenæ* Fitch, and *Caryæfallax* Walsh MS., the antennæ of this mother bark-louse are three-jointed, joints one and two short and sub-equal, and joint three longer than one and two put together. The young larvæ are about 0.01 inch long, and of the usual shape. Almost as soon as hatched—as is also the case with the larvæ of all the allied galls—these larvæ stray away to found new galls. The galls themselves are very abundant about July 24th, but by August 12th they were almost all empty and gaping open below. Out of twenty or twenty-five examined at this last date, all but one were empty, and that one contained only a single bark-louse egg. The gall-insect is infested by a Mite (*Acarus* family) and also by a *Chalcis* fly.

This Bark-louse gall may be readily distinguished from the Plant-louse gall, *Caryæ globuli*, Walsh, with which Dr. Shimer has unaccountably confounded it, not only by its being only one-third or one-fourth as wide across, but by opening below with a roundish,nipple-like hole,whereas the latter opens below with an elongated slit. (See *Proc. Ent. Soc. Phil.* VI. p. 275.) Moreover, the former almost always contains eggs, the latter never; because the Bark-louse is oviparous, and the Plant-louse, at all events, so long as it remains in the gall, is invariably viviparous.

will gather upon that and leave the others unmolested. In proof of this assertion, I quote the two following passages from among a number of similar ones, the first from the Report of the Winter Meeting of the Fruit-growers' Association of Western New York, Jan. 23, 1867, the second from the *American Journal of Horticulture*, Sept., 1867, p. 163:

"F. C. Brehm thinks the Clinton the best vine to draw rose-bugs from other vines, and keeps one in his garden for that purpose."

"When I saw a paragraph in a Horticultural Paper, advising grape-growers to keep one vine of the Clinton in the garden for the use of the rose-bugs, I thought it merely a feeble joke; but experience teaches me that it is no joke at all. I have a Clinton vine at a little distance from a dozen other kinds, and its leaves are entirely riddled by the Rose-bugs; while I have not found six bugs on the other varieties, and none at all on the roses. I pity the want of taste displayed by the bugs, but am glad to find that the Clinton is good for something.——Since writing the above, I have found bugs in abundance on the Franklin; but that only strengthens the case; for the Franklin is much like the Clinton and just as worthless."

J. M. M., Junr.

INSECTS INFESTING THE GRAPE.—On the Root.

CHAPTER IV.—The Grape-root Borer. (*Ægeria polistiformis*, Harris.)

This insect, which strikingly resembles the common Peach Borer, (*Ægeria exitiosa*, Say,) in all its stages, both in size, in shape, and in the general style of its coloration, was observed fifteen years ago by Dr. F. J. Kron, of Albemarle in North Carolina, to be very destructive to the cultivated grape-vines there. I see from the *Monthly Reports of the Agricultural Department for* 1867 (pp 329—330,) that Mr. H. J. Krone, of the same place—who may probably be a relative of Dr. Kron's, though his name is printed with an E at the end of it—"gives discouraging reports about the destruction of grape-vines in that region" by this same Borer in 1867. In the same *Monthly Report* it is stated that "a correspondent in Cincinnati writes that a new enemy has attacked the grape-vines in that vicinity, and describes its work as similar to that of the North Carolina *Ægeria polistiformis*." Lastly, in the summer of 1867, Mr. C. S. Jackson, of Danville, Kentucky, sent me specimens of the larva of this very same insect, along with pieces of the grape-vine roots on which it was operating. "Here in Central Kentucky," he says, "I have noticed, for a year or two past, spots throughout the vineyards suffering from

decay; and where the vines are taken up and examined, this worm is found on almost every root."

Now, Danville in Kentucky lies about a hundred miles to the *south* of Cincinnati, Ohio, but it actually lies about ten miles to the *north* of Cobden, in Illinois, where grape-vines are beginning to be grown pretty extensively. Consequently, even if it should turn out that the Cincinnati correspondent of the Agricultural Department has raised a false alarm, yet as this pernicious borer indubitably exists in large numbers at Danville, there is a reasonable probability that it may within a few years, now that grapes are being grown so extensively, spread from that point into Southern and Central Illinois. It may perhaps have even done so already. Hence it appears to be a useful precaution to describe the insect and its operations in such a manner, that it may be recognized at once, wherever and whenever it may occur, by our Illinois grape-growers; more particularly as, being hitherto considered an exclusively Southern insect, it is entirely unnoticed in Dr. Harris's excellent book on *Injurious Insects,* and only receives a passing notice of eight lines in Dr. Fitch's very useful *Reports on the Noxious Insects of New York.*

Unlike the common Peach Borer, this larva lives exclusively underground, the mother-moth depositing her eggs on the collar of the grape-vine close to the earth, and the young larvæ, as soon as they hatch out, immediately descending on to the roots. They seem to confine themselves entirely to the bark and sap-wood of the roots, leaving the heart-wood untouched, which of course renders their operations much more destructive to the life of the vine. The roots that I received from Kentucky were internally sound and solid, but externally they looked all of them as if a drunken carpenter had been diligently scooping away the sap-wood with a quarter-inch gouge, almost their entire surface being furrowed by crooked and irregular channels, semicircular in their outline if a cross-section of them was made, inside some of which lay the larvæ, with their naked backs touching the surrounding earth. According to Mr. Krone, however, "the larva working underground mines and destroys the vine-roots, and *being shielded by the bark* defies the action of remedies for its extermination." When full-grown these larvæ measure from 1 inch to $1\frac{3}{4}$ inch in length; and are whitish, elongate, 16-legged grubs, scarcely distinguishable from those of the Peach Borer. Like that insect, they form an oval, pod-like cocoon of a gummy substance covered with little bits of wood and dirt, inside which they pass into the pupa state. These cocoons may be met with at various times through the summer near the roots of the infested vine; and, as is also the case

with the Peach Borer, the Perfect Moths make their appearance above ground at various times through the summer. According to Dr. Kron, they are found about the vines and on the wing in North Carolina from the middle of June to the middle of September, during which time they couple and lay their eggs. The following description of the Moth, which I have not yet succeeded in rearing, is copied from Harris, (*Rep. Am. Pom. Soc.*, 1854, p. 10.)

"The moth of the Grape-vine Borer has a body of a dark brown color, more or less tinged with a tawny orange on the sides, and banded with bright yellow upon the edge of the second ring of the hind-body. The thorax and shoulder-covers, and the fourth ring of the hind-body, are more faintly edged with yellow, or with tawny orange. The feelers, antennæ beneath, and legs are also orange-colored; the fore-wings are dusky; the hind-wings transparent,but varied and edged with black. The female has a little orange-colored tuft on each side of the tail, and the males have two tufts on each side, the middle pair longer than the others. The males are more numerous, more active, and smaller than the females; they measure from 0.50 to 0.60 inch in length, and their wings expand from 1 inch to 1.15 inch. The body of the female varies from 0.60 to 0.90 inch in length, and her wings expand from 1 inch to 1.50 inch."

The curious reader, who has noticed just now that I said that the Grape-root Borer was briefly referred to by Dr. Fitch, will perhaps be astonished, on referring to that gentleman's *New York Reports,* to find that no such insect as *Ægeria polistiformis* is to be met with, in any of the three indexes attached to the three volumes of those *Reports.* It may perhaps be worth while to explain this little scientific mystery. After the term "Ægeria" had been applied by the European entomologist Fabricius in the year 1807 to the genus of insects to which both the Peach Borer, the Squash-vine Borer, and the Grape-root Borer belong, and had been universally current in the scientific world for half a century thereafter, some indefatigable genius, rummaging among old books, discovered that another European entomologist, Scopoli, had given the name of "Trochilium" to the same group of insects in the year 1777, or 30 years *before* Fabricius's name was published. Hence, according to what is called "the law of priority," the name "Trochilium" has now very generally taken the place of the name "Ægeria;" and the very same insect which in 1854 Dr. Harris designated as *Ægeria polistiformis* was in 1856 designated by Dr. Fitch as *Trochilium polistiforme.* If the rules of nomenclature, promulgated long ago by the British Association for the Advancement of Science, had been regarded in this case, the term "Ægeria," having been once universally adopted, would never have been changed. But unfortunately these rules have been too generally neglected, and the "law of priority" has been for many years back enforced with the ut-

most rigor in the scientific world. Hence scientific phraseology is in a perpetual state of flux, chopping and changing about from year to year, as often as some obscure writer, whose writings perhaps are not worth one cent, but who had the good fortune to be born before his betters, is discovered to have named a genus or a species before the author of the current name published that name in the scientific world. The inevitable consequence is, that a great deal of valuable time, that might be usefully expended in studying out scientific *facts,* is frittered away in studying out scientific *phrases;* and an entomologist, who would keep up with the age, has to be perpetually altering the names in his cabinet, without himself gaining thereby one single new idea, or adding one iota to the general fund of scientific knowledge. To my mind, the naturalist who rakes up out of the dust of old libraries some long-forgotten name, and demands that it shall take the place of a name of universal acceptance, ought to be indicted before the High Court of Science as a public nuisance, and on conviction sent to a Scientific Penitentiary, and fed there for the whole remaining term of his scientific life upon a diet of chinch bugs and formic acid.*

All underground insects are peculiarly difficult to combat, 1st, because the mischief done by them is generally discovered too late for any remedy to be applied, and 2nd, because entomologists know less of the Natural History of this group of insects than of that of almost any other group, owing to their being so secluded from observation and experiment within the bowels of the earth. In the case of this Grape-root Borer the only *direct* remedies that Science can at present indicate are, to dig up all the roots of vines known or suspected to be infested by it, destroying carefully all the larvæ and cocoons found thereon, and to catch and destroy all the winged moths noticed round the vines, so as to check the farther multiplication of the species. There is a *preventive* remedy, however, which, in the event of this

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*On this vexed question Dr. Schaum has the following excellent remarks: —"I am much opposed to the adoption of these obsolete names, which Mr. Dawson has substituted for the well-known and generally adopted appellations, in right of priority. * * If we cultivate Entomology for the sake of knowledge, and not for the sake of nomenclature, I can see no benefit arising from an enquiry into the data of the synonyms compiled (and very often erroneously compiled) by Schœnherr, but on the contrary a waste of time which can be better employed in exact observations. What we want for the sake of knowledge is *stability and uniformity* of nomenclature, not an upsetting of it by the substitution of old forgotten and very doubtful names, published in works without, or with but little, scientific merit." Stainton's *Ent. Ann.*, 1860, pp. 121—2.

insect ever becoming unbearably numerous in Illinois, can be resorted to with the fullest confidence in its success. Both Dr. Kron and Mr. Krone have ascertained by long observation and experiment, that the Scuppernong grape-vine—which is a cultivated variety, according to Dr. Asa Gray, of the wild Southern Fox Grape (*Vitis vulpina*)— is entirely exempt from the operations of this Borer; and the former gentleman has been successful in grafting both the European Grape (*Vitis vinifera*) and many of our cultivated North American varieties upon Scuppernong stocks, and has found that he thereby entirely escapes the ravages of the Borer. I do not find that this Southern variety of grape has hitherto ever been grown in Illinois; but there can be little doubt that it would stand the climate, at all events of Southern Illinois, *as a stock;* and, if the worst comes to the worst, rather than give up growing grapes, we shall have to fall back, as our last resource, upon Scuppernong and Southern Fox Grape stocks for all our cultivated varieties of the grape.

Since the above was written, Mr. Geo. Husmann, the Missouri King of the Grapes, has obligingly informed me that he "has had the Scuppernong on his grounds at Hermann, Missouri," which lies over 100 miles to the north of the latitude of Cairo, Illinois, "for 15 years; that it has fruited there several times, but that the fruit is entirely worthless." He adds further that this Grape-root Borer "has been familiar to him for the last 15 or 20 years, and that it now and then destroys a vine in the vineyards in his vicinity, but does not seem to increase."

INSECTS INFESTING THE APPLE.—On the Fruit.

CHAPTER V.—The Apple-worm *or* Codling-worm Moth. (*Carpocapsa pomonella,* Linnæus.)

Both Harris and Fitch seem to doubt the fact of there being two distinct broods of this insect every year, the one generated by the other, although Kollar and other European writers assert that it is so in Europe. Possibly Harris & Fitch may be right, as regards the more northern latitudes in the United States; but in the latitude of Rock Island, Illinois, (41 degrees, 30 minutes,) I am satisfied that there really are two distinct broods, for the following reasons:—

1st. On July 18th and 21st, I cut into 70 windfall apples bored by this insect, and found larvæ in but three of the 70. Subsequently about the middle of August I cut into a large number, and found larvæ in almost every one.

2d. On August 22d I cut into an apple, that was very extensively bored and had manifestly raised a larva to maturity. Yet it

contained a very small larva, only three-sixteenths of an inch long, and altogether too young to have devoured so much of the core and pulp of the apple. Hence it is plain that, after the first larva had made its exit, an egg was deposited on this apple, from which proceeded a second larva.

3d. I have repeatedly, from apples, pears, and even crab-apples, of the same year's growth, raised the winged moth in the latter end of July and the forepart of August. Now, if such moths generate at all, where can they lay their eggs, except in the fruit of the same year's growth, which presupposes a true second brood? Unless indeed we assume that they live in the moth state from the latter end of July and the forepart of August all through the winter and until the following June, which can scarcely be believed. If, on the other hand, they do not generate at all, then nature has made them in vain, which is incredible.

4th. On October 23d, I found seven or eight cocoons of this insect, in the crotches of a badly infested tree, among the loose scales. On being broken open, they were found to contain the larva still unchanged into pupa. Consequently, these were evidently destined to pass the winter in the cocoon, and come out in the moth state in the following June, in time to lay their eggs in next year's crop of apples.

On the whole, although the two broods run into one another by scattering individuals generated unusually late or unusually early—as is often the case with species proved to be really double-brooded, for example, with the imported Gooseberry Sawfly (*Nematus ventricosus,* Klug)—yet the great bulk of the later individuals must be generated by the earlier individuals, and the earlier individuals must be generated by those that had passed the preceding winter in the cocoon, and did not assume the winged state till some time in June. In other words, the species is "double-brooded," as it is called.

The practical inference to be drawn from the above is, that a fruit-grower must not believe, because a certain tree is entirely free from apple-worms till the end of July, that therefore it will be safe from them for the rest of the year. Such a tree may be, and often is, attacked by the second brood of this insect in the latter part of the summer, when the apples are quite large; and it is these infested apples that often hang on the trees to the last and ripen, whereas those infested by the earlier brood are, as a rule, too small and puny to withstand so extensive an erosion, and mostly fall to the ground. I have observed that where early and late apple-trees grow on the same spot of ground, the early brood chiefly attacks the early fruit, and the late brood the late apples. A shoemaker or a tailor or a blacksmith would

probably not be able to distinguish one kind of apple from another when they are both immature; but the mother Codling moth, as it appears, distinguishes them with ease. And yet almost any mechanic would tell you, that one of these despised "bugs" is as much a mere unthinking machine, as the awl or the needle or the anvil that he himself works with!

Almost universally, there is but a single larva in a single apple at one and the same time. But on August 15th, I found a windfall which contained *two* larvæ, one of which had evidently entered at the calyx or blossom end, and the other at the foot stalk. I have noticed a few specimens where the egg had been attached to the cheek of the apple, and the young larva that hatched out from it had made its entry there. And I have also observed that, where two apples hang so as to touch one another, the larva bred in one of them will sometimes be depraved enough, in the mere wantonness of power, to bore out of it into the adjoining fruit, though there is an abundance of food remaining for it in its original home. Probably, on careful search, similar cases of wanton destructiveness might be met with in the human species.

Others as well as myself—Dr. James Weed, for example, of Muscatine, Iowa—have observed that the larva of this insect often leaves the apple, *before* that apple falls to the ground. Consequently the gathering up and destroying windfalls, either by man-power or hog-power, though an excellent prescription so far as it goes, is not an infallible panacea.

After all, the best and most reliable remedy, so far as my limited experience goes, when we have palliated the evil by destroying the wormy windfalls day after day, is Dr. Trimble's hay-band system; which should be commenced about July 15th and continued till about September 15th, looking under the hay-bands every day or two for the cocoons. The cocoons themselves may be readily recognized by their being composed of a gossamer-like, filmy, white silk, inside which the larva or pupa will be found. On this important subject, I append the following passage, which I find in the *Western Rural* of Nov. 9, 1867.

"A correspondent of the *Country Gentleman* states that, in the orchard of Dr. Trimble, of New Jersey, he had an opportunity of witnessing the efficacy of what he calls 'Dr. Trimble's remedy for the apple-worm.' Hay-ropes had been wound around the trunks of the trees, and large numbers of insects had been caught, some of which had attained the pupa state, while others having only just reached their hiding-place were still larvæ. The whole number of insects

caught on one tree during the season amounted to a thousand. Trees, which formerly had nearly all their fruit destroyed, were, under this treatment, bearing very fair crops. A complete extermination could not be expected, while the neighboring fruit-growers took no precaution against the insect. Dr. Trimble applies two belts or bandages, one of them two or three feet high and the other higher. He thinks that the worms under the higher belt descend the tree before the fruit drops, and those under the lower crawl up from the fallen fruit on the ground."

It must not be supposed that, because this insect has swarmed so prodigiously in 1867, therefore it will necessarily be as numerous, or even still more numerous, in 1868. In 1865 it abounded near Rock Island and elsewhere; yet in 1866, in the same localities, it was very scarce and did no appreciable damage. In 1867, on the contrary, I can hear of but two States—Kansas and West Virginia—in the northern half of the Union, where it has not been more ruinously destructive than was ever known before.

The Pear, being so closely allied to the Apple, has, as we should naturally anticipate, been extensively attacked by the Apple-worm in 1867. Harris merely observes that "the worms, often found in summer pears, *appear* to be the same as those that infest apples." But, from a lot of infested pears sent me from Philadelphia, under the idea that they contained a peculiar species, I have myself bred the veritable Codling Moth; and before I had bred it, I assured my correspondent that the larva was identical with that of the Codling Moth. Mr. Parker Earle, President of the Fruit-growers' Association of Southern Illinois, informs us in his Annual Address to that Society in 1867, that "in many sections of country nine-tenths of the pears are reported as ruined by the Codling Moth in 1867."

CHAPTER VI.—The Apple Maggot Fly. (*Trypeta pomonella*, Walsh.)

Fig. 2.

In Illinois the fruit of the apple-tree is at present bored up only by the Apple-worm, in the Natural History of which we have just been investigating some few points. In Massachusetts, in Connecticut, in New York, and probably in Vermont also, it has for the last few years been troubled, in addition, by a still more destructive pest, popularly known as "the Apple-maggot." The Apple-worm is an imported species, probably introduced into the Eastern States from Europe about the commencement of the present century, and has only penetrated into Illinois within the last ten or fifteen years. The Apple-maggot, on the contrary, is a native-American species, which

naturally feeds upon our native haws or thorn-apples and probably upon our native crabs also, and which I know to have existed in the State of Illinois for at least five or six years.* In the Eastern States, from unexplained causes, it has within the last few years acquired the habit of attacking the cultivated apple, as well as the wild haw, and has, by the laws of inheritance, transmitted that habit to its descendants, who have reveled in the foreign delicacy, and increased and multiplied at a prodigious rate, till they have become almost an unbearable nuisance. In Illinois, on the contrary, so far as I can learn, the species has never yet acquired this peculiar habit, and perhaps may never do so. But there can be little doubt that the descendants of the improved and highly-civilized apple-maggots in the East will, in process of time and by slow degrees, spread gradually to the West; or they may be suddenly introduced in a barrel of Eastern apples into some point at the West, and thence radiate in all directions and colonize the country. What is very remarkable, the species is new to science, and was briefly described by myself for the first time in the *American Journal of Horticulture for December*, 1867 (pp. 338—343.) How I obtained the requisite facilities for investigating its history, and what is its peculiar mode of operating upon the apple-crop in the East, I will now proceed to explain.

The following paragraph appeared in the *Circular* of the Oneida Community (November 12, 1866,) published at Wallingford, Connecticut; and shortly afterwards, at my request, the Editor was kind enough to send me several specimens of the larvæ.

"Two months ago we were congratulating ourselves on a fair crop of winter apples. To all appearance they were freer from worms than we had known them in this section for years. But alas! our hopes are again blasted. Although the *apple-worm* (the larva of the Codling Moth, *Carpocapsa pomonella*) is not so numerous as in some seasons, *the apple-maggot* seems to be as prolific as ever. Two weeks ago we overhauled two hundred and fifty bushels of apples, that we had gathered and placed in store for winter use, and of that number we threw out fifty bushels, most of which had been rendered worthless, EXCEPT FOR CIDER or hogs, by one or the other of the above-named insects; and still the work of destruction goes on. *The apple-worm* by this time has ceased his work, or nearly so, but the depredations of

*The scientific reader will, perhaps, like to know that, after I had published in the *Journal of Horticulture* the fact, that the species bred by myself five or six years ago, from Illinois haws, was identical with that bred in 1866—7 from apples received from the East, I sent a specimen of the former to Baron Osten-Sacken, and he found it be undistinguishable from a specimen of the latter which I had previously sent him.

the apple-maggot continue up to the present time, converting the pulp of the apple into a mere honeycomb, and rendering another over-hauling soon indispensable."

I hope cider-drinkers will make a note of the fact that maggoty apples can be converted into excellent cider. They would probably not like to eat the maggots bodily; but they smack their lips after drinking the expressed juice of millions of these tender young larvæ. Yet, as the old saying is, "One may as well eat the devil as drink his broth."

On December 28th, 1866, Mr. W. C. Fish, of East Falmouth, Massachusetts, sent me a further supply of these same apple-maggots, with the following account of their operations in his vicinity:

"This insect is very numerous in this section of country, being much more abundant in the thin-skinned summer and fall apples than in the later varieties. It seems to increase every year. Within a few rods of the house in which I am writing, stand five or six trees of the old-fashioned variety called Hightop or Summer Sweets. On these trees the crop of apples is annually rendered worthless by this insect, which tunnels the fruit in all directions. Apples which, when taken from the tree, appeared sound, would in the course of a few weeks, as soon as they became mellow, be found to be alive with these pests, sometimes to the number of six or more in each apple, although not commonly as many as that. I have found that, in most cases, the fruit had been previously perforated by the larva of the Codling Moth (*Carpocapsa pomonella*), before becoming inhabited by this insect."

During the same winter I also received pupæ of this same insect from my intelligent correspondent, Isaac Hicks, of North Hempstead, Long Island, New York, who finds it a great pest there. According to Dr. Trimble, the State Entomologist of New Jersey, "this new and formidable enemy of the apple prevails generally throughout the Hudson River country, but has not yet reached New Jersey." (*N. Y. Sem. Tribune,* July 17, 1867.) Mr. Calvin Ward, of Vermont, complains of a larva, which is probably identical with the Apple-maggot, boring his apples for the last few years in all directions, and adds that "this insect does more injury to him than all other insects combined," and that "in 1865 it injured his apples to the extent of one-half their value, though it is not the only one that preys on them; but in 1866 it has not been so bad." (*Prac. Entom.* II. pp. 20—21.) Certainly, from Mr. Ward's description, the larva which he complains of could not have been the common Apple-worm, though it may possibly have been Dr. Fitch's Apple-midge, respecting which see above, p. 22.

In July, 1867, from larvæ and pupæ received from Connecticut, Massachusetts and New York in the preceding winter, I bred several specimens of the perfect fly, a magnified figure of which is given herewith. (Fig. 2.) It will be seen at once that it has no resemblance whatever to the Codling Moth or moth of the Apple-worm, which is a four-winged insect with easily removed scales on its wings, like all other moths or "millers," and belongs to the Order Lepidoptera; whereas the perfect insect of the Apple-maggot is a two-winged fly, with no scales whatever on its wings, and belongs to the same Order (Diptera) as mosquitoes, gnats, midges, horse-flies, house-flies, etc., and to the same great group as our common house-fly. The larvæ also of the two insects are notably unlike. The Apple-worm (fig. 2b) is a cylindrical, 16-legged caterpillar with a large, dark, horny head and a dark horny patch behind its head; the Apple-maggot (fig. 2a) is a legless maggot, tapered to a point in front and not very unlike the larvæ of the different blow-flies that lay their eggs, or "fly-blows" as they are commonly called, on meat. Even the pupæ are quite dissimilar. For that of the Apple-worm shows the wings of the future moth, soldered indeed to the side of the body, but still plainly visible, while that of the Apple-maggot is what is technically termed a "coarctate" pupa; that is to say, instead of the larva moulting its skin to assume the pupa state, the larval skin is retained whole and unbroken, although greatly contracted in length, by the pupa, so that the true pupa can only be seen by dissecting away the shrunken skin of the larva. The little elongate-oval, mahogany-brown bodies that we often see in cheese infested by the common Cheese-fly (*Piophila casei,* Linnæus) afford a familiar example of this kind of pupa; and any one may easily satisfy himself that they are really the pupæ of the cheese-fly, by enclosing a few of them for a few days in a vial, till the perfect fly comes out from them. Again, the Apple-worm, as we have already seen, is double-brooded, the first brood of Moths appearing in June and laying its eggs in the blossom end of the apples when they are no bigger than hazel-nuts, and the second brood of Moths appearing about the beginning of August to work on the more fully matured fruits. The Apple-maggot, on the other hand, is single-brooded, the perfect flies not making their appearance till July, and the maggots, produced from the eggs inserted by the ovipositors of these flies into the flesh of the apple, not changing back again into flies till the following July. Furthermore, the Apple-worm spins a slight silken cocoon above-ground; while the Apple-maggot spins no cocoon at all, and burrows under-ground to pass into the pupa state, remaining under the surface of the earth, without eating anything, all through the

winter and until the middle of the following summer. Even the modes in which the two larvæ operate upon the apple are perceptibly different. The Apple-worm burrows chiefly in the core of the apple and the part immediately around the core, though it occasionally makes an inroad upon the pulp, and often bores its way out through the cheek of the apple. The Apple-maggot, on the contrary, so far as I can find out from the statements of my correspondents and from the specimens of infested apples sent me, never penetrates into the core, but tunnels exclusively the flesh or pulp of the apple, making therein little, rough, roundish, irregular and discolored excavations about the size of peas; which, when several larvæ are at work on the same fruit, often run together, so as to render the whole a mere mass of useless and disgusting corruption.

This Apple-maggot Fly must be carefully distinguished from Dr. Fitch's Apple Midge (*Sciara mali,*) previously referred to in connection with the Grape Midge. (See above, p. 22.) The whole Order of Two-winged Flies (*Diptera*)—with the exception of the small and very anomalous group comprising the Bird-flies (*Ornithomyia*) and the Sheep-tick—is divided into two grand groups, one of which (*Nemocera*) comprising the Musquitoes, Buffalo-gnats, Midges, Crane-flies, etc., has long, many-jointed antennæ in the Fly State; while the other group (*Brachycera,*) comprising the Horse-flies, the *Syrphus* flies, many of which are cannibals, the parasitical *Tachina* flies, and several families containing the House-flies, Onion-flies, Cabbage-flies, etc., has short antennæ aparently composed of only three joints, and usually with a slender bristle growing out of the last. It is to the former of these two great groups that Dr. Fitch's Apple Midge belongs. It is to the latter of these two great groups that my Apple-maggot Fly belongs. They are therefore radically and fundamentally distinct.

It only remains, in order to complete the History of this very beautiful, but destructive species, that I should annex descriptions of it in all its stages, so that for the future it may be scientifically recognizable. A species of the same genus, not very unlike it in the Fly state, (*Trypeta solidaginis,* Fitch,) produces a round gall or swelling about the size of a hickory nut on the stem of a species of Golden-rod (*Solidago*) inside which, any time in the winter and early spring, its fat white larva may be easily discovered reposing calmly in a little central cell surrounded by white pithy matter. By placing some of these galls, which are very common both in the East and in the West, in any convenient vessel, the Fly may be easily obtained from them as the spring opens. According to my friend Baron Osten-Sacken, who has paid special attention to the Order Diptera,there is a Euro-

pean species of the same genus (*Trypeta signata,* Meigen, otherwise called *cerasi,*) which infests the cherry, the barberry, and several other fruits.

The Apple Maggot Fly. (*Trypeta pomonella, Walsh.*) *Head* rust-red; eyes and all the bristles black; front edge of the face and hind orbit of the eye, more or less tinged with white. *Thorax,* shining black; a humeral fillet, (vitta) and all but the extreme base of the scutel, white; on each side of the thorax, above, a gray fillet, opaque, with short, dense, gray pubescence. *Abdomen,* black, pubescent, with dusky hairs; the tip edge of the four basal segments white above, the white terminal edge of the first of these segments with short, white hairs: beneath, except the tip and a more or less distinct medial fillet, dull rust-red. Oviduct, short. *Legs,* pale rust-red; the four high thighs, except the knees, black; the tips of the four hind paws (tarsi), and sometimes the front thighs, tinged with dusky. *Wings,* whitish-glassy, banded with dusky somewhat in the form of the letters I F—the I placed next the base of the wing, and the lower end uniting rather indistinctly with the lower end of the F; the base and the extreme tip of the wing being always glassy. The anterior end of the I commences on the transverse shoulder-vein and extends over the basal two-thirds of the second basal cell, and the whole of the third basal cell, beyond which it unites in a faint cloud with the foot of the F. The main leg of the F extends nearly in a transverse direction across the middle of the wing, straddling the middle transverse vein and the tip of the first longitudinal vein; from which last proceeds the anterior branch of the F, skirting, but not quite attaining the costa and the apex of the wing, and terminating on the tip of the fourth longitudinal vein. The posterior branch of the F commences opposite to the middle transverse vein, straddles the hind transverse vein, and terminates on the tip of the fifth longitudinal vein. Length of body, 0.15—0.20 inch; expanse of wings 0.30—0.43 inch.

Described from six males bred from Eastern apples, July 15th—23rd; two males and one female bred from Illinois haws July 23d—28th. I am informed by Mr. Sanborn, of the Boston Society of Natural History, that the species is quite commonly taken in Massachusetts, although nobody had hitherto recognized it as the Apple Maggot Fly. According to Osten-Sacken, "this species seems to belong to the same group of *Trypeta* as the European *signata,* living in fruits, and not in the heads of plants belonging to the botanical family *Compositæ,* as the majority do." There are forty-two species of *Trypeta* exclusive of *asteris* Harris, which Osten-Sacken has since proved to be a mere synonym of *solidaginis* Fitch, described in Loew's and Osten-Sacken's work on *N. A. Diptera,* and from all of these it differs essentially, though it comes pretty near to *cingulata* Loew. After I had satisfied myself upon this point, and forwarded a specimen to Baron Osten-Sacken, this gentleman was kind enough to inform me that, since the publication of the work on *N. A. Diptera,* Loew had described in certain foreign publications, not accessible to me, several additional N. A. species belonging to this genus. Subsequently, at my request, he examined the descriptions of all these additional species, and ascertained that not a single species of them agreed specifically with my *pomonella.* So that now there can be no reasonable doubt that the latter has hitherto been undescribed as a North American insect,

though there is still a possibility that it may prove to be identical with some *Trypeta* found in the Old World.*

THE LARVA (fig. 2a) is of a greenish-white color, 0.15—0.20 inch long and about four and one-half times as long as wide, cylindrical behind, with the tail-end squarely docked, tapering in front from the middle of the body to the head. Head pointed, but narrowly excavated (emarginate) in front; its inferior surface with two slender, bluntish, coal-black hooks projecting in front, when the mouth is protruded, at the base of which there is a smaller pair connected with the base of the others, like the antlers on a buck's horn. At the base of the first segment behind the head, a dorso-lateral, transverse, pale-brown, flattish, rough tubercle. Last segment below, with two pale-brown, horny, rough tubercles, each composed of three minute thorns longitudinally arranged; and above, with two whitish, retractile ones, each pair of tubercles transversely arranged.

THE PUPARIUM scarcely differs from the larva, except in being of a pale yellowish-brown color, and contracted in length, so as to approximate to an oval form and be only two and one-half instead of four and one-half times as long as wide.

INSECTS INFESTING THE APPLE.—On the Leaf.

CHAPTER VII.—THE RASCAL LEAF-CRUMPLER. (*Phycita nebulo*, Walsh.)

I figured and described this small moth, and the curious house in which its larva lives, for the first time in the *Prairie Farmer* for May, 1860, (p. 308) and the description was subsequently reprinted in the *Proceedings of the Boston Society of Natural History,* (Vol. IX. pp. 312—3.) It infests in the northern part of Illinois both apple, crab and plum trees, the larva traveling about in a little crooked horn or case, and tying together with silken threads the terminal leaves of young twigs, inside which it feeds at its leisure. Frequently, in passing from twig to twig, it anchors its case by strong silken cables to the naked side of a limb, and in this situation it has very much the appearance of a piece of dry bird's dung. It remains in this case in the larva state all through the winter and until the forepart of the following June; shortly after which date it changes into the pupa state, from which the winged moth emerges about the middle of July. I formerly conjectured that there were two or more broods of this species every year, but I am satisfied now that there is but one. It is not preyed on by any *Ichneumon* fly, so far as I have discovered; but I have bred from it a species of the parasitic *Tachina* family, so closely resembling, both in size and coloration, the common House-fly, that almost any ordinary observer would be sure to mistake the one for the other.

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*Loew has since informed Osten-Sacken that "*Tryp. pomonella* is a new species, and not identical with any European species."

When this insect does not occur in extraordinary numbers, it is probably rather beneficial than otherwise on large trees, by operating as a summer pruning and thereby checking the exuberant growth of wood and throwing the tree to fruit. But in 1859 I found them so abundant on one of my apple-trees, that if I had not destroyed them, I believe they would have greatly injured it; and in June, 1867, I received specimens of it from "J. M. K.," of Clarence, Iowa, with the statement that "it had destroyed his apple-crop for the last three years." When the trees are bare in the dead of the year it is a very easy thing to find the little bunches of dry leaves—tied to the twig by silken bands—in which the larva has hidden its case, to protect itself from the cold blasts of winter; and it may then be readily picked off the tree, and destroyed by forcibly crumpling up the whole establishment, leaves and all, between the fingers. Comparatively a very slight pressure will effect this; for we are dealing here not with a hard shelly beetle, but with a soft delicate caterpillar. Although this insect is so common in Northern Illinois, and I have noticed plenty of them annually for the last ten years near Rock Island, and they are equally abundant, as I am assured by Mr. C. V. Riley, near Chicago, yet, on the most careful search, I could not discover a single specimen, even in the dead of the year, in the apple orchards near Cobden in South Illinois; and Mr. Riley tells me that he also has failed to find it there. Neither, so far as I can ascertain, does it occur in the Eastern States; and most certainly it is not mentioned either by Dr. Harris or by Dr. Fitch. We may set it down, therefore, for the present, as and exclusively north-western species.

INSECTS INFESTING THE APPLE.—On the Bark.

CHAPTER VIII.—The Oyster-shell Bark-louse. (*Aspidiotus conchiformis*, Gmelin.)

There is no noxious insect existing throughout the length and breadth of the United States, about which more nonsense has been written and talked—concerning the Natural History of which more erroneous ideas prevail—and against which a greater number of ridiculous and useless panaceas have been recommended—than the Oyster-shell Bark-louse. The reasons are many. In the first place, except for a very brief period of the year, all we can see of it is a small, motionless and apparently lifeless scale, closely appressed to the bark, of precisely the same color as the bark itself, and so totally unlike the popular idea of a "bug," or even the scientific idea of an animal, that it is sure not to be noticed by the unpractised eye, except when it has

increased so prodigiously as to overspread almost completely a whole limb. So closely indeed at this period does it resemble a mere vegetable growth, that when, as often happens, it is located round the base of a young apple-twig or apple-spur, scarcely any but the acute eye of a field-entomologist can distinguish it from the natural wrinkles and creases of the bark. Again: these scales, after the eggs underneath them have hatched out, and the young larvæ have dispersed themselves in various directions, still adhere to the bark for years, and even 12 or 18 months after the eggs have hatched, present exactly the same external appearance as they did in the first instance. Hence nothing is more natural than for an inexperienced person to suppose, that these old dead last year's scales, with no eggs whatever under them, are scales which were alive but yesterday, and which have been killed, eggs and all, by some ridiculous and useless wash, which he has been recommended, on what he supposes to be the highest authority, to apply to them. Moreover, as I shall afterwards explain, there is a minute and almost microscopic Mite (*Acarus*), that preys most extensively upon the eggs under the scales during the autumnal and early spring months, not only in the West, but also in the East; and this opens another door for error and delusion. Some quack nostrum is applied—a few dozen scales are lifted, and the eggs under almost all of them are found to be shriveled up to nothing—and then *hey presto!* the conclusion is jumped to, that it was the quack nostrum, not the Cannibal Mite, that had killed the eggs, and the wonderful discovery is paraded immediately in the nearest Agricultural Journal. Lastly, at one particular time of the year, as I shall afterwards show, a very slight degree of friction with a stiff brush will destroy these Bark-lice—horse, foot and dragoons. Now see what follows from this fact. Some worthless Patent Wash is applied to the infested limbs with such a brush at this particular period—it is in reality the *brush,* and not the *wash,* that destroys the Bark-lice—and yet the cozened fruit-grower firmly believes, that it is the GRAND INFALLIBLE NEVER-FAILING ANTI-BARK-LOUSE SPECIFIC that has done the business for them, and the papers ring with certificates of the great reliability of the newly-discovered nostrum, sold by all Druggists and Patent Medicine Venders at the low price of $5 per pint.

It would be easy to fill a volume with the history of the different remedies that have been published against this miserable Bark-louse. Lime-washes, soda-washes, tobacco-water, dry ashes, tar, fish-brine, potash-washes, sulphur-washes, common brine, solutions of soap, solutions of quassia, solutions of aloes, the ammoniacal fumes of sheep-manure, and combinations of two, three and four of the above ingre-

dients in every conceivable proportion that the wit of man could devise—have all been strongly recommended in print on what seemed to be the very best authority. Yet, with the exception of two or three of these articles—and these only if they be applied at a particular period of the year—I believe them all to be equally useless and inefficacious. Indeed, after filling one volume with certificates from the most respectable sources highly recommending, one after another, every one of the above panaceas, it would be easy to fill another volume with the doleful lamentations of men, who have tried them and found them worthless. I know several orchardists troubled by this vile pest, who have arrived at the conclusion, after experimenting in vain with a dozen different remedies, that it is no use trying to fight it, and that their apple-trees are irretrievably ruined and "gone up."

As with all other Noxious Insects, before we can fight this Bark-louse understandingly, it is necessary to know who and what she is, how she is propagated from year to year, how she spreads from one tree to another, and what are her peculiar habits and mode of life. I put her in the feminine gender, because, without a single exception, all the scales that come under the notice of the fruit-grower contain eggs under them, and are consequently all of them females. And here. at the very outset, the inexperienced observer is often involved in error and confusion. There are two perfectly distinct Bark-lice, with different habits and modes of life, commonly found in Illinois on the apple-tree, which are popularly confounded together—by a very indefinite application of the Definite Article—under the appellation of "THE Bark-louse." The first—which is the one with which we are now more immediately concerned—is a species introduced into the Eastern States more than seventy years ago from Europe, but which only penetrated into Illinois about fifteen years ago; occupying at first the districts bordering upon Lake Michigan, where it committed terrible ravages, and thence spreading gradually Westward and Southward, till only a few years ago it touched the Mississippi River. The second—which we will call "Harris's Bark-louse," and which will be referred to more fully in the following Chapter—is a native-American species, and has existed for time immemorial both in the East and in the West, its original home being our native crab-trees, upon which I observed it many years ago. The first cannot thrive except in comparatively northern latitudes; for even in Champaign Co., in Central Illinois, as I am informed by Mr. M. L. Dunlap ("Rural"), although it has been long known there, yet it does not increase so as to be at all formidable; and, as I was told in Southern Illinois, it actually dies, when it is introduced there upon young apple-trees brought from the

north.* Harris's Bark-louse, on the contrary, flourishes vigorously, to my certain knowledge, so as to be a great pest in the latitude of Philadelphia, which is somewhat south of Champaign; and in Missouri it probably extends to a point at least 180 miles further south, where it does a great amount of damage. It occurs also in considerable numbers throughout the whole State of Illinois, but is nowhere anything like so destructive as the Imported Species. Indeed almost all our worst Noxious Insects have been imported from the Old World, and are far more destructive than the corresponding species indigenous to North America—a curious fact which I have explained and illustrated at some length in the *Practical Entomologist*, (Vol. I., No. 12.)

"But," the reader will ask, "how am I to distinguish these two Bark-lice, the one from the other?" The answer is short and simple. The scale of the Oyster-shell Bark-louse is the shape of a very elongate pear, considerably hunched, and of the exact color of the bark. That of Harris's Bark-louse is usually the shape of an egg, almost entirely flat, and of a pure milk-white color. Lift up the former with the point of a penknife any time between the middle of September and the middle of May, and you will see underneath it a score or two of very minute milk-white eggs, many of which will often drop out and on any dark surface look like so many grains of corn-meal. Lift up the latter in the same manner and at the same period, and you will find that the eggs, though of the same size and shape as those of the other species, are not milk-white, but blood-red. If these distinctive characters are not sufficient—and they certainly ought to be sufficient in all conscience—the reader can refer, in addition, to the figures of the two kinds of scales given in the *Practical Entomologist*,

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*Since the above was written, I have received the Oyster-shell Bark-louse from Mr. J. Huggins, of Macoupin county, Central Illinois, with a statement that it swarms at Shipman, in that county, on two trees that were imported eight years ago from New York, though "the other trees in the orchard are not yet seriously affected." On examining the infested twigs sent by Mr. Huggins, I found that about 19-20ths of the eggs under the scales had been destroyed by the same Cannibal Mite that, as will be afterwards shown, operates upon them in Northern Illinois. Now, in North Illinois, the largest proportion of eggs, that I ever found to be destroyed by this Mite, was only two-thirds. Hence, I infer that the Mite is a far more efficient check upon the multiplication of this Bark-louse in Southern than in Northern latitudes. Certainly if this Bark-louse had been introduced into any county in North Illinois eight years ago, it would have been all over the county long before now; whereas, in Macoupin county it seems to have scarcely spread beyond the two trees on which it was originally imported eight years ago.

(Vol. II., p. 31.) Both scales are alike in being about one-eighth or one-tenth inch long.

The OYSTER-SHELL BARK-LOUSE is not double-brooded, as Dr. Harris erroneously supposed, but single-brooded. That point is now conclusively settled by the unanimous testimony of many recent observers; and, if necessary, I could confirm the fact. In the latitude of Rock Island, the eggs hatched out about the 4th of June in 1867, the spring of that year being unusually backward. In McHenry county in 1854 Dr. E. G. Mygatt—who published an admirable Paper on the habits of this insect in the *Transactions of the Illinois State Agricultural Society* (I. pp. 514—7)—found them to hatch out about May 23d; at Batavia, Kane county, about May 17th; and at Oswego, Kendall county, on May 18th. "But," as he adds, "in no case were they found till after the apple-blossoms had fallen, and the young fruit commenced growing—it is vain to look for them before." Of course, the time of hatching will vary somewhat with the season and the latitude; but Dr. Mygatt's rule will probably be found sufficiently accurate for all practical purposes. According to my Journal, my apple-trees were in full blossom on the 26th of May in the year 1867; so that by June 4th, the date when most of the young bark-lice were hatched, the young fruit must have been just about set. I noticed that on May 31st, or four days before the general hatch, although not a single egg had then hatched, some few of them—perhaps one out of every 40 or 50—instead of remaining milk-white had turned yellow. Changes of this kind are quite usual with the eggs of different kinds of Bark-lice shortly before hatching-time; for I have myself observed in the case of several distinct species, that the color of the future larva often shows through the translucent shell of the egg a few days before it hatches out. The young larvæ on June 4th, when observed under the lens, were nearly of the same oval shape as the eggs, that is to say about $1\frac{3}{4}$ times as long as wide; but they were considerably larger than the eggs, of a yellowish color, with distinct beak and antennæ, *and with their three pairs of legs equidistant at their origin from each other.* This last character I have found to be universal in the larvæ of all the numerous kinds of Bark-lice with which I am acquainted, and, as we shall see afterwards, it is an important one both theoretically and practically. At this date the young larvæ were scattered so densely over the bark, that it looked as if it had been sprinkled with fine corn-meal; and at a casual glance no one would suppose them to be living animals, were it not for the fact that many of them might be seen, even with the naked eye, to crawl slowly along, having the appearance of little moving pale dots. Seven days

subsequently, and probably sooner, these larvæ had all become stationary, and never moved afterwards from the point in the bark to which they had attached themselves. At this date, they presented under the lens the appearance of conspicuous, flat, white scales, oval and one-third longer than broad, their long diameter being now about equal to one-third of the extreme transverse diameter of the old scales. The white appearance of these larvæ I found to be due to a white powdery secretion from the general surface of their bodies; which being removed by a moist camel's-hair pencil, their bodies reassumed their original pale yellow color. As with the larvæ of many other Bark-lice and some Plant-lice, there were, in addition to this powdery secretion, threads of exceedingly fine, hair-like, cottony floss irregularly attached to them, and evidently secreted from the general surface of their bodies. At this period they could without much difficulty be detached from the bark by a moist camel's-hair pencil; but already they had lost almost all appearance of organization. Their legs, which only seven days before were distinctly articulated and as large comparatively as in ordinary insects, and which then discharged all the functions of locomotion with ease, were now almost entirely obsolete; so that even on holding the insect up to the light, under the most powerful Stanhope and Coddington lenses, but the faintest traces of legs could be perceived. Their antennæ had now disappeared altogether. As to any organized beak, I could discover nothing of the kind; but not improbably it might have been inserted in the bark and broken off short by detaching the insect from that bark. Motion in this creature there was none whatever; and but for having seen them crawl about with ease only seven days before, and knowing that in the course of two or three months almost every one of these apparently inanimate scales would generate scores of living white eggs, I should never have supposed them to be living animals. On the preceding day, i. e., only six days after the general hatch, I had closely examined dozens of them, and could not perceive that a single one moved in any way. According to Dr. Mygatt, who says that his trees were watched closely by the members of his family, the first bark-louse seen to hatch out was on the 23d of May; and after the 27th not one was seen to move. So that the process of degradation, by which the animal loses all its locomotive and sensorial organs, probably commences about three days after the hatch, and is almost completely consummated in the space of four days.

Agassiz lays it down as a universal rule, that "the earliest condition of an animal cannot be its highest condition—it does not pass from a more perfect to a less perfect state of existence." (*Methods*

of Study, p. 75.) But here—as also in the case of the common Barnacle, which begins life as a highly-organized locomotive crab, and ends life by becoming permanently attached like a plant to a ship's bottom, and by having many of its former organs either aborted or degraded—we clearly find an exception to what is undoubtedly a general, though not a universal rule. Nor is the exception confined to this one species of Bark-lice. So far as I have ascertained, it prevails universally throughout two of the commonest genera of the great Family of Bark-lice (*Aspidiotus* and *Lecanium.*)

After this most anomalous and wonderful transformation, the body of the original insect grows scarcely at all, the total increase in its length or breadth being only about one-sixth. But now commences another most strange and anomalous process. From the tail end of the limbless and apparently lifeless scale, which is all that remains of the once highly-organized larva, there gradually in the course of a few days protrudes backwards a thin membranous sack, closely appressed to the bark like the original scale, and so far as outline goes forming an elongated continuation of it, but differing from it very obviously in color and texture. In 14 days' time this elongated sack has become in many specimens as long as the original body; and it grows and increases backwards at a prodigious rate thereafter, till by the middle of August the whole has assumed its permanent shape; and what remains now of the original body of the larva forms merely a minute, yellowish-brown, oval plate, pressed down obliquely upon the forward end of the so-called scale-insect, just as one of these stylish modern trencher-caps is pressed down upon the forehead of a fashionably dressed young lady in the year of our Lord 1867. Examine the Oyster-shell Bark-louse when you will, from the middle of August to the middle of the following May, and you will find it is externally always the same. In front there is what is left of the originally perfect, but now degraded and defunctionate larva, being an oval scale, of a somewhat shining yellowish brown color, and with one longitudinal ridge running from end to end, on each side of which are several indistinct transverse grooves, being all that remains to indicate that this was once a highly-organized animal, divided by the usual transverse sutures into the normal 13 segments found in the larva of almost every insect. Behind this yellowish-brown scale—which I shall for convenience' sake call "the larval scale"—may be seen a rather longer and wider one—which I shall call "the medial scale"—without any ridges or grooves and of the same opaque greenish-brown color as the bark, but often, especially at its hind end, tinged more or less with yellowish; and behind this again, and closely connected with it, the rest of the enor-

mous elongated sack protruded in the space of about two months from the tail end of the larva, which is always of the same greenish-brown color as the bark. This posterior sack, which I shall call the "anal sack," is in its widest part about twice as broad as the "larval scale" is long, and, together with the "medial scale," is from 4 to 10 times as long as the "larval scale," but most commonly about 8 or 10 times as long. If the whole scale-insect is lifted up by the point of a penknife about the middle of August, the white eggs previously referred to may be found underneath it, the delicate part of the protruded sack that adheres to the bark being usually more or less torn open by the operation; and the eggs remain under the scale, without further development, all through the winter and until the middle of the following May. In the course of the winter they doubtless freeze and thaw, and thaw and freeze, scores of times; but, as with almost all insects when they are hibernating, this produces not the slightest effect upon their vitality.

Authors, who have never traced a Bark-louse day after day through all these astonishing transformations, have erroneously hinted that the "larval scale" represents the head, that the "medial scale" represents the thorax, and the large "anal sack" behind the whole represents the abdomen of a normal insect. (See Fitch, *New York Reports,* I. p. 257.) But no such thing can possibly be; for there is externally no perceptible change in the "larval scale," except a very slight one in size, from the days when the first rudiments of the "medial scale" and of the "anal sack" are protruded from behind it, to the day when both are fully developed. Consequently, as the "larval scale" represented originally both head, thorax and abdomen of a normal insect, and as it ever afterwards remains unchanged, it cannot afterwards represent the head alone of a normal insect.

What may be the precise nature of this singular "medial scale" and "anal sack," is hard to tell with absolute certainty. They are not, however, peculiar to the Oyster-shell Bark-louse, but are characteristic of the whole genus (*Aspidiotus,*) to which both this species and Harris's Bark-louse belong. In a very elongated and narrow species of the same genus, the Pine-leaf Scale-insect, (*Aspidiotus pinifoliæ*, Fitch,) found on the leaves of the White Pine (*Pinus strobus*)—which, by the way, I have ascertained to contain in November eggs of the same blood-red color, as those of Harris's Bark-louse —the "anal sack" is of a pure milk-white color, and the "larval and medial scales" are very distinct from each other and from the "anal sack," and are both of them of a yellowish-brown color. In an undescribed species, which may be called the "Black-willow Bark-louse"

(*Aspidiotus salicis-nigræ,* new species,) and which I find on the bark of the Black willow (*Salix nigra,*) the perfected scale-insect is of exactly the same size and shape as the perfected Oyster-shell Bark-louse; but, instead of being of the same color as the bark, it is milk-white, with the "larval and medial scales" pale yellowish-brown, precisely as in the Pine-leaf species, and in Harris's Bark-louse; and moreover the eggs under the scale, instead of being milk-white, are blood-red, as in the above-named two species. I incline to believe that, throughout this genus, what I have called the "medial scale" and the "anal sack" is formed by the anal surface of the original young larva being at two successive periods abnormally dilated and extended backwards, in the form of a sack closed at tip; and that, after this process is accomplished, the insect always moults or sloughs off the whole of the external scale, including both "larval scale," "medial scale" and "anal sack," which has been formed in the manner detailed above; and the eggs are then developed inside the scale and at the tail end of the moulted insect, and afterwards laid in the ordinary manner under the protecting scale. In confirmation of this theory, it may be observed here that on August 15th, I found, under numerous scales of the Oyster-shell Bark-louse that I then lifted, a white fleshy, juicy mass still enveloping some of the eggs, and that, under many others that I dissected in the autumn, I found towards the small or head end of the scale a dried-up mass, (which was apparently the legless body of the mother Bark-louse,) perfectly separated from the enclosing scale. In the case of Harris's Bark-louse, as will be shown hereafter, I found under the scale in the autumn, before any of the eggs were developed, *the living and moving body* of the mother Bark-louse, perfectly separated from the scale. And in a closely allied species found in Sweden, the description of which is quoted from Dalman by Harris, the very same thing is stated to occur. (*Injurious Insects,* p. 255.) So that, in these two cases at all events, it is impossible to believe, as most authors have hitherto done, that, at the time when the eggs are developed the outer scale is part and parcel of the living Bark-louse. Neither is it reasonable or consistent to hold with Dr. Harris that, in the case of the Oyster-shell Bark-louse, the scale is composed of the dried-up body of the insect, while in the case of Harris's Bark-louse it is a mere cocoon. For in both of these two cases the scale consists of precisely the same three parts, arranged in precisely the same manner, namely the "larval scale," the "medial scale," and the "anal sack;" and if it is a cocoon in one case, it must be a cocoon in both. But, after all, these matters though of the highest scientific interest, are of no manner of practical importance.

Hitherto we have spoken only of the mother Bark-louse. I have not actually bred the males of the Oyster-shell species; but there is good reason to believe that a small percentage of the larvæ—considerably less than five per cent. on a rough estimate—which never, like the egg-bearing females, have any long "anal sack" grow out of their tails, subsequently develop into males, and again acquire the power of locomotion. Even in the winter time, the empty shells of these individuals may be seen still adhering to the bark. Throughout the Bark-louse Family, it is the males only that ever acquire any wings, or even any rudiments of wings; and in comparison with the females of this species, the males, judging from the minute size of the scales out of which they, in all probability, come, must be very small and insignificant fellows indeed. The same law obtains throughout the whole Family.

It is a curious question how a species of insect, which, like the female of this Oyster-shell Bark-louse, never acquires any wings at all, and which loses even its legs when it is only a few days old, and becomes as stationary as a cabbage for the remaining period of its existence, can pass from tree to tree in the manner that we know it to do. Dr. Fitch, indeed, talks very glibly and fluently about the Bark-lice on some trees, that were "perishing" with their enormous numbers in the month of September, "preferring starvation at home" to being "poisoned by invading" some neighboring trees that had been dosed with one of the thousand-and-one Anti-Bark-louse Specifics. (*N. Y. Rep.* I., p. 38.) He might as well talk about the apple trees, in a badly-cultivated orchard, "preferring starvation at home" to emigrating into some well-kept and well-tended orchard. For, in September and, indeed, during the entire year, with the exception of three or four days in the spring, the female Bark-louse is as incapable of emigrating as an apple tree; and, as to the males, they, of course, could do no harm to a tree, even if they covered its entire surface; for, like all male insects belonging to this family, they have no beaks or mouths of any kind, and of course they lay no eggs. In my opinion, the only way in which, as a general rule, Bark-lice can spread from tree to tree, when the boughs of those trees do not interlock, is by a few of the very young larvæ, when they are first hatched, and are scattered over the limbs of a tree in such prodigious numbers, crawling accidentally on to the legs of some bird, that chances to light upon that tree and afterwards flies off to another. I have long observed that, when a tree first begins to be attacked by Bark-lice, it is only particular limbs and branches that are at first infected, and that these will be swarming while the rest of the tree will be free from

lice. And I have further observed, that it is the lower horizontal limbs and branches, or such as birds, with the exception of Woodpeckers and Nut-hatches, would most naturally perch on, that are first attacked. The process of transmission, however, is by no means so sure and speedy as in the case of winged insects—for example, the Plant-lice (*Aphis* family.) For every one must have often noticed trees standing not far from one another, some of which were swarming with Bark-lice while others were not in the least infected. If all the birds in the world were killed off, I believe that these Bark-lice, in a very few years, would cease to exist. They would first of all destroy the trees of which they had already got possession; and then they would all of them die of starvation themselves. As to the popular idea that all Bark-lice crawl along the ground from one tree to another, that is altogether out of the question. They only possess the power of crawling for a few days, and they crawl so exceedingly slow, that I do not believe that in that whole time they could make more than a few yards, even on a perfectly smooth surface. Is it likely, then, that they can ever crawl down the trunk of their own tree, make their way over many yards of ground which is always more or less rough, and then crawl up the trunk of another tree and pass along on to its branches?

Mites (*Acarus* family) are not true Insects, but belong to the same Class (*Arachnida*) as the Spiders and the true Ticks, as distinguished from the so-called Sheep-tick, which is a wingless true Insect and—if the hibernicism may be pardoned—a wingless Two-winged Fly (Order *Diptera*). In common with the rest of the Class to which they appertain, Mites differ essentially from all the true Insects in having the head and thorax all in one piece, without any free joint or even any suture between them. They differ further, almost all of them, in having *eight* legs in the perfect state; whereas all true insects without a single exception have in the perfect state exactly *six* legs, never more and never less. In very many genera of Mites, however, as in certain genera of Insects, the first pair of legs are not used in walking, but are constantly vibrated up and down as they progress, after the fashion of antennæ. Now in Insects, where the head and thorax are always distinct, as the antennæ always grow out of the head and the legs out of the thorax, there can be no possible confusion between the leg and antenna, no matter what the function of the leg may be; because, if the organ in question grows out of the thorax, it is to be considered as a leg, even if it discharges the duties of an antenna. But in Mites, where the head and thorax are confounded together, just as they are in a Crab, or a Lobster, or a Crawfish, the

inexperienced observer, although none of the great Class to which the Mites belong have any antennæ at all, is yet very apt to consider the front pair of legs as antennæ, whenever he sees them used as antennæ. Consequently, as a general rule, the easiest mode for beginners to distinguish a Mite from a true Insect is, to see whether the animal under examination has a distinct head or not. If it has, it cannot be a Mite. If it has not, it cannot be a true Insect.

So far we have been talking about the structural peculiarities of the *perfect* Mite and the *perfect* Insect. In the *larva or imperfect state* the case is somewhat different. Just as, *in the larva state,* many Insects have legs so minute that they are scarcely distinguishable, others again have no legs at all, others again, in addition to the six normal jointed legs, have at their tails a sham leg (or "pro-leg") or fleshy excrescence not divided into joints like the true legs, but still performing the same functions as they do, and others again have from four to sixteen of such sham legs strung along the hinder part of their bodies, besides having the normal six true legs in front; so, *in the larva state,* many Mites have only six legs, although, when fully grown, they acquire an additional pair. In this case, as these Mite-larvæ are always exceedingly minute in size, it is sometimes not very easy to distinguish them from the similarly minute larvæ of certain Bark-lice and Plant-lice, to which they bear a strong general resemblance. There is, however, one distinctive character by which, so far as a pretty extensive observation goes, I believe that the very young six-legged oval larvæ of the Mites may be always readily distinguished from the very young six-legged oval larvæ of the Bark-lice and the Plant-lice. In the two latter groups the three pairs of legs are always equidistant, or nearly so, from each other, at their origin on the lower surface of the body. In the former group the two front pairs of legs are placed close to one another on the lower surface of the body and not very far from the front end, while the hind pair of legs are placed wide apart from the others and not very far from the hind end. In a somewhat wide experience with these creatures, I have met with no intermediate grades whatever in these very remarkable characters.

Of course, as the larvæ of all Bark-lice and Plant-lice have antennæ, and those of Mites have none, if you can make out the antennæ clearly in the larvæ that you have under examination, they cannot be Mite-larvæ. But as the larvæ of Bark-lice and Plant-lice very frequently do not raise up their antennæ as they crawl along, and as the legs can generally be made out pretty

distinctly whenever larvæ of any kind are crawling along, characters drawn from the legs are evidently the most generally available.

The number of distinct species of Mites to be found in the United States is rather large, but still very greatly inferior to the number of distinct species of Insects found within the same limits. Unlike the true Insects, they are all of them quite small in size, the largest Mite known to me being much less than one-tenth inch in length. They swarm everywhere; but their Natural History is so far almost entirely a sealed book to the scientific world, because no one hitherto has devoted his exclusive attention to them. I am myself acquainted with no less than twenty distinct species, that form curious "galls," or unnatural growths, upon the leaves of various trees. One of these causes the singular pod-like growths, about one-eighth inch long, upon the upper surface of the leaf of the wild plum-tree (*Prunus americana*),* which often swarm so prodigiously, that I calculate that the number of young Mites, in one small clump of Plum-trees, frequently exceeds the number of human beings now living and breathing upon the face of this earth. This will perhaps be considered a wild exaggeration; but see what the figures themselves will say. I have often counted as many as sixty of these galls on a single leaf, and each gall contains towards the end of July several scores of microscopically minute young Mites. Such a leaf will therefore contain about 3,000 young Mites, and putting the human population of the whole globe even at the enormous number of 900,000,000, it will only take 300,000 such leaves to verify my estimate. Now, Dr. Fitch has calculated (*New York Reports* I. p. 127) that there are about 17,000 leaves on a young cherry-tree only ten

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*For the benefit of the scientific reader, I copy from my Journal the description of this one gall. The general reader will be thankful that I omit the descriptions of the other nineteen galls:

Gall PRUNI CRUMENA, new species. On Prunus americana. A fleshy, smooth, elongate, blunt-tipped, fusiform, opaque, hollow gall, constricted at its base, and with a few erect hairs, 0.10—0.16 inch long, and about four or five times as long as its extreme breadth. Walls of the gall thin. Color outside a very pale green often tinged with rosy; inside, rough and of a rosy color. Always grows upon the upper surface of the leaf, whole trees frequently swarming with it, the number of galls on a single leaf varying from one to sixty. Ten galls opened July 27th all contained *Acarus* larvæ, scores of them in each gall. These larvæ are exceedingly minute, of a hyaline-whitish color, of the usual elongate-oval form, thrice as long as wide, six-legged, with their legs arranged as usual. They are very sluggish. Some of a yellow color were crawling on the leaves outside the galls. A similar but distinct gall (*Cerasi crumena*, Walsh MS.) is almost equally abundant on the leaf of the Wild Black Cherry (*Cerasus serotina*.)

feet high; and I presume that there would be fully as many on a plum-tree of the same size. Let us suppose that in a particular group of such plum-trees there are, on the average, only 3,000 leaves on each tree fully stocked with young Mites, as calculated above; or, if any leaves are less fully stocked, as many leaves in all as would be equivalent to 3,000 fully-stocked leaves. Then it follows that there need only be 100 plum-trees, each about ten feet high, in the group, to make up the whole number of 300,000 fully-stocked leaves, which, according to the calculation, are required in order to sustain a population of young Mites, equal to the very highest estimate that has ever been published of the entire human population of the earth!

Now pluck one of the gall-bearing leaves from such a group of 100 plum-trees, which might easily grow upon a piece of ground much smaller than a common-sized village lot. Open one of the galls on it. Examine its inhabitants with a powerful magnifier. You will see at once, that all this infinite multitude of infinitesimally minute beings are as perfect in every limb, and in every joint of every limb, and probably in every nerve and muscle of their tiny bodies, as the gigantic animal that is watching their operations through a piece of glass. They are all busy. They are all evidently healthy, and happy, and in the full enjoyment of their existence. They contribute in no wise to our pleasures or to our necessities; neither do they molest or trouble us in any way whatever. We are separated from them by as wide a gulf, as if they were denizens of the far-away planet Neptune. And yet we fondly dream, in our vainglorious hallucination, that all this vast world of life and happiness—so minute in size, but so inconceivably large in numbers—was created for our sole benefit, and has no right to exist but by our sovereign permission and at our good will and pleasure!

All the Mites, however, do not feed upon living vegetable substances, like these gall-makers that I have just been picturing to the mind of the reader. As with the true Insects, many groups of them feed upon decaying substances, either of animal or vegetable origin, many are Parasites, and many others are Cannibals. For example, the common Cheese-mite, an imported European species, feeds upon decaying cheese, where, when it is once established, it soon multiplies with the most astonishing rapidity. Again: the common Itch, in that two-legged animal that Linnæus designated as *Homo sapiens,* is caused by a microscopically minute Mite (*Acarus scabiei,* Linnæus) burrowing under his skin, and there carrying out the great Law of Nature, "Increase and multiply and replenish the earth." This species, therefore, is a true Parasite. Again: I have noticed many

species of Mites that are what I have called "Cannibals," haunting leaf-galls constructed by certain Plant-lice and Bark-lice, and feeding apparently upon the tender bodies of the unfortunate young lice. Galls made by other groups of insects they do not usually enter, because these last are invariably closed, till the gall-maker gnaws his way out. But galls made by Plant-lice and Bark-lice—which insects have no jaws at all to gnaw with, but only a beak to suck with—always burst open towards the latter part of their existence, so as to allow the young Lice a free exit into the external world. Hence into these the wandering Cannibal Mites, who are always remarkably fleet-footed in the mature state, find a ready entrance, and often carry death and desolation into what was before the happy home of a flourishing colony of Lice. "Eat and be eaten; kill and be killed." Everywhere this is the great universal Law of Nature.

Of these Cannibal Mites, I have discovered that there is at least one species, and perhaps more than one, that preys most extensively upon the eggs of the Oyster-shell Bark-louse; insomuch that upon a particular apple-twig infested by these Bark-lice I have found, on lifting and carefully examining six hundred scales about the last of October, that at least two-thirds of the whole number were either already gutted, or were undergoing the process of being gutted, by the minute larvæ of a Mite.* What I believe, though I am not absolutely certain, to be the eggs of this Mite are deposited here and there upon the bark among the scales, in little patches of six or eight, and are exceedingly minute, smooth, shining, perfectly globular bodies, rather less in diameter than the transverse diameter of the egg of the oyster-shell Bark-louse. Most of them are blood-red, but some, which appear to be the empty shells of such as have already hatched out, are transparent and colorless. Repeatedly, on raising the Bark-louse scales both in the autumn and in the early spring months, I have found from one to eight of the larvæ of some kind of Mite—whether hatched out or not from the above-mentioned eggs is not perfectly clear—interspersed among the eggs of the Bark-louse. In

*During my attendance at the inauguration of the Horticultural Society of Northern Illinois, at Mt. Carroll, December 18th—20th, 1867, and before I had said a word there about these Cannibal Mites, but after the whole of this chapter was in the hands of the printer, I was much gratified by hearing Dr. H. Shimer, of Mt. Carroll, inform the meeting that he had himself discovered that the imported Bark-louse was preyed on quite extensively by a species of Mite (*Acarus.*) Thus, as often happens, the same discovery has been made at the same time, by two independent observers. Of course, Dr. Shimer's evidence is cumulative proof, if any be needed by any one, of the reality of the discovery.—December 21, 1867.

some of these cases the eggs of the Bark-louse were sound and untouched; in others there were only a few of them sucked dry and shriveled up; in others again, at one end of the scale the eggs would be sucked dry and at the other end perfectly plump and sound, the young Mites being stationed in the middle, as a mower stations himself between the standing grass and the swath that he has already cut; finally, in still other cases, nothing but the empty shells of the eggs remained, and occasionally the hungry young Mites might still be discovered among those empty shells, kicking and struggling in the snug retreat that they had so ruthlessly desolated, as dogs sometimes fight over a bone that has been already picked clean.

Towards the spring, or late in the autumn, many of the scales, some of them still containing a few eggs, may be observed to have rather large, irregular, ragged holes in their external surface, quite unlike the smaller, regularly-rounded holes, bored by Parasitic insects when they make their escape from the shell of an insect of this size that they have preyed on. Early in the autumn scarcely any such holes are to be met with in the recently-formed scales. I suspect that these ragged holes are the work of the Mites, and that, after having sucked all the eggs dry, they feed upon the dry scale, until hunger compels them to vacate the tenement and search out a scale that has not as yet been preyed upon by their brethren. Dr. Fitch mentions that he found a small Parasitic larva—which as usual bored a small round hole to escape by—to be very common under these scales. I have never met with any such larva; but I have occasionally seen scales, both of the Oyster-shell Bark-louse and of Harris's Bark-louse, perforated by just such a small round hole as Dr. Fitch describes; and I should judge them to have been made by a parasitic four-winged Fly (*Chalcis* family or *Proctotrupes* family.)

Some of these Mite-larvæ that were discovered in May, are described in my Journal as being of a glassy-white color, six-legged, and with the hind pair of legs placed as usual far backwards; their bodies oval, 2½ times as long as wide, and not at all hairy, and of about the same length as the egg of the Bark-louse. Others, noticed about the last of October, agreed pretty accurately with the above description. Others, again, found about the same time, differed in being rather larger and more elongate—thrice, instead of 2½ times as long as wide—and in having 8 distinct legs, the two hindmost pairs separated by a very wide interval from the two foremost pairs. These were probably the pupa form of the others. All of them had the thorax separated from the abdomen by a transverse suture; and, as is universally the case, so far as I have observed, with immature

Mites, were sluggish in their movements. On the other hand, all Cannibal Mites that I am acquainted with, are, in the adult state, exceedingly active, and run with astonishing rapidity for creatures of their minute size.

I think it not improbable that there are several distinct species of Mites that prey upon these Bark-louse eggs. I have descriptions in my journal of adult Mites, belonging to what seem to be four distinct species, two of which were merely found running about among the scales, one was found under a scale where one-third of the eggs were white and plump and the rest yellowish and shrunken, and the other one under a scale in company with two Mite-larvæ, that were undoubtedly preying upon the eggs of the Bark-louse. As is usual with Mites arrived at maturity, there was no distinct transverse suture, dividing the head-thorax from the abdomen, in any of these four. I have not been able to succeed in rearing any of the Mite-larvæ found under the scales to the adult state; so that I will mercifully forbear for the present inflicting upon the general reader long descriptions of adult Mites, which, although they were certainly some of them found under very suspicious circumstances, yet cannot be positively proved to prey upon Bark-louse eggs, and in any case cannot be identified with the larvæ that I know to prey upon these eggs. Not improbably, some of what I have supposed to be distinct species of adult Mites, may be merely the two sexes or two different stages of one and the same species; or very possibly, as is common in several families of insects, species of Mites, which are perfectly distinct in the adult state, may be undistinguishable in the larva state.

I have only to add, by way of caution to the reader who may desire to verify the above new and very curious facts, that these young Mites, being so nearly of the same size, shape and color as the eggs of the Bark-louse among which they are found, and being also exceedingly dull and inactive in their movements, are not very easily recognizable. By long and attentive watching, however, and by trying several scales one after the other, a leg or two will at last be perceived, even under a common pocket magnifier, lazily flopping about; and even when the legs cannot be seen, a good lens will often discover the transverse suture across the body of the young Mite, which of course is not to be seen in the unhatched egg of the Bark-louse. It will be found that the shrunken eggs recently preyed upon by the Mite are of a yellowish color; while the empty egg-shells (from which the young lice have hatched out,) that are constantly met with under old last year's scales, are at first, not of a yellowish, but of a transparent white color. It is therefore among such

shrunken eggs as are yellowish, not among such as are white, that these Cannibal Mites are to be looked for. So strongly, again, do these young Mites resemble the young Bark-lice when the latter are first hatched out, that even so practised an observer as Dr. Fitch evidently mistook the one for the other. For he says that the young Bark-lice of this species mostly hatch out about May 26th, but that so early as May 12th he found *some still under the scale* with "three pairs of legs, two placed anteriorly, the other posteriorly and distant." (*New York Reports*, I. pp. 36—7.) As the legs of all young Bark-lice are equidistant or very nearly so, and those of all young six-legged Mites, so far as I know, precisely in accordance with the above description, these must clearly have been, not young Bark-lice, as the Doctor supposed, but young Mites. But even out of the errors, to which we are all of us subject, we may sometimes deduce useful and important truths. For Dr. Fitch's error proves to us, that Mites must prey upon Bark-louse eggs, not only in Illinois, but also in New York.

And now, after this protracted and tedious description of the Natural History of this mischievous insect, which has been made necessary by the prevalent errors and misconceptions on the subject—let us approach the great practical question, "How are we to get rid of this pest?" It is with considerable reluctance that I enter upon this question, because I have in operation a long train of experiments upon this important point, which are not yet finally concluded. I should much prefer, therefore, to wait till I can treat the matter as a whole at some future day, instead of taking it up piecemeal now. Still, as the conclusions at which I have already arrived seem to be of great practical moment, imperfect and fragmentary as they may be, I will lay them before the reader. They may be briefly stated thus:—

1st. Strong tobacco-water has no effect whatever upon these Bark-lice, no matter at what time of the year it may be applied.

2d. Strong alkaline washes have no effect whatever upon these Bark-lice, no matter at what time of year they may be applied.

3d. A strong solution of soap will kill almost every one of these Bark-lice that it touches *shortly after they hatch out;* but has no effect whatever upon *the perfected scale.*

4th. Petroleum, or kerosene, or probably any oily or fatty substance, will kill every Bark-louse, eggs and all, that it actually touches at any time of the year. And there is pretty good evidence, that such substances, if spread thinly over a great part of the surface of a tree, and even if spread over its entire surface, are not perceptibly injurious to it, or at all events not invariably so.

5th. Scrubbing the limbs of a tree with a stiff brush, shortly after the Bark-lice have hatched out, will destroy them and remove them from the infected surface; but no such mechanical appliance can remove or otherwise affect the perfected scale, simply because it sticks too tight, and is of too hard and solid a texture.

6th. By scraping the bark with the edge of a knife or other such tool, even the perfected scale may at any time of the year be removed and destroyed.

To give all the details of all the experiments that I have made, bearing upon the above general rules, would occupy entirely too much space and only weary the reader. But I may be pardoned, perhaps, for giving the details of a few of them, and for particularizing several facts obtained from other sources, in order that it may be seen upon what kind of evidence my general conclusions are based. Each statement is numbered, so as to correspond with the six general laws already laid down.

Statement 1st.—On June 12th, 1867, being eight days after the Bark-lice had hatched, and probably about four or five days after they had become permanently stationary, I prepared some tobacco-water, by boiling for three hours one part, by measure, of common smoking-tobacco and seven parts of water, renewing the water as it boiled away. This fluid I squeezed with a sponge over a badly infested branch, so as to wet the whole of it thoroughly both above and below, using no brush or swab of any kind, so as absolutely to eliminate the effects of mechanical friction upon the young Bark-lice. I had previously pruned the branch so as to cut off all communication with neighboring branches, except at its origin; and of course I labeled it and registered it in my Journal. From time to time through the summer I examined it, and found the young Bark-lice apparently growing as vigorously as on the rest of the tree. On October 30th I cut off a portion of it, one foot in length and averaging one-third of an inch in diameter, and examined the scales one by one under a lens. This piece, be it observed, was so distant from the origin of the branch which I had washed with the tobacco-water, that it was very improbable that any amount of young Bark-lice could afterwards have crawled out on to it from the other parts of the tree, even supposing them to have retained their original powers of locomotion. I found, on examining it, at least 200 scales containing good, plump, healthy eggs, and about 400 that had either been completely gutted by the Mites, or were undergoing that process. There were about seven or eight scales from which no "anal sack" had developed; these might possibly have been larvæ killed by the tobacco-water, but I

took them for scales from which males had developed; for this is about the proportion of such scales usually met with in branches that have not been medicated in any way. The old dead last year's scales upon this piece of a branch, I did not think it necessary to count. Hence, I infer that strong tobacco-water cannot kill the Bark-louse at any period of its existence; for if it has no effect upon it when it is in the tender larva state, *a fortiori* it will have no effect upon the matured or partly matured scale.

That most accurate observer, Dr. Mygatt, arrived at similar results. "When I had ascertained," he says, "the hatching season, I fondly hoped that the decoctions of quassia and tobacco, which I have for several years used on the Plant-lice, (*Aphides,*) would also destroy the young Bark-lice (*Coccids;*) but in that I was doomed to be sadly disappointed on trial." (*Trans. Ill. State Agr. Soc.* I., p. 516.)

Statement 2d.—On June 12th, 1867, I prepared a solution of common saleratus, which, as soda has been very much cheaper than potash ever since the mode of obtaining it from common salt was discovered, was, in all probability, nothing but purified soda. It was mixed in the proportion of one part, by measurement, of saleratus to fifty parts of water. This I applied, precisely in the same way as the tobacco-water in the preceding statement, to another branch, prepared and labeled in a similar manner. Repeatedly, as the summer progressed, I examined this branch, and the young Bark-lice on it seemed to be growing as nicely as on the rest of the tree. The results, on cutting off, October 30th, a piece of the same size and length, and similarly situated, as compared with that used in the preceding experiment, were almost precisely the same. For I found 201 matured scales containing plump, healthy eggs, and nine that I took to be male scales, though possibly some or all of them might have been young larvæ killed by the soda-wash. I did not count the old, dead last year's scales, or those of the current year which were infested or gutted by Mites; but I estimated that they were in all about 200 in number. From this experiment I concluded that a solution of soda will not kill the Bark-lice even in the larva state; and I draw the same inference as to the effect of alkaline solutions upon the matured Bark-louse, that I have already drawn in the tobacco-water experiment.

The proportion of soda used was nearly that recommended in the *Horticulturist* of March, 1867, namely, "one pound of potash to six gallons of water;" for, as every druggist knows, a pint of such substances as soda is nearly the equivalent of a pound. All accounts

seemed to agree that stronger solutions were injurious to vegetable life. But from the following statement, made by Wm. Mead, Jun., of Taunton, Massachusetts, it appears that even the very strongest alkaline solutions have no effect upon Bark-lice. "To kill the scale-insect," he says, "upon my pear trees, I have tried potash—one pound to a gallon of water—which has no effect upon the insect, except to make it brighter." (*New York Sem. Tribune,* March 16, 1866.) Judging from the date of publication, Mr. Mead must have operated in the dead of the year, and therefore upon the perfected scale. Dr. Houghton, of Philadelphia, used in the summer time a wash of the same unusual strength, as he has informed me—one pound of "concentrated lye" to one gallon of water—upon the other species (Harris's Bark-louse) that were infesting his pear trees in prodigious numbers, without its producing the least perceptible effect in diminishing their ravages, though he was of opinion that it injured the trees to a considerable extent.

STATEMENT 3d.—On June 12th, 1867, I prepared a solution of good, home-made soft soap, manufactured from soap-grease and what is sold under the name of "concentrated lye," and is probably nothing but impure soda. I took one part, by measurement, of soap to six parts of water, and stirred the mixture over a fire till it got warm and had about the consistence of thin paint. This I applied, in the same way as the tobacco-water in the first experiment, to a branch prepared and labeled in the same manner, except that I had unfortunately omitted to trim off a few of the small, terminal twigs, and neglected to apply the soapy solution to those twigs. On examining this branch, from time to time through the months of June and July, it was quite plain that the great bulk of the young Bark-lice on it had ceased growing and were dead, though they still adhered firmly in their original form to the bark. On October 27th, I cut off a portion of this branch, of the same size and length as in the other two experiments, and carefully lifted and examined, under the lens, all the matured scales upon it, whether of this year's or last year's growth. I found but seven scales containing plump, healthy eggs; the number of last year's scales, and of those that had been operated on by Mites, I did not count, nor did I estimate them separately from each other; for, up to this day, I had not become aware of the nice distinction between last year's scales, containing *white* egg-shells, and scales recently gutted by Mites, which contain *yellowish* egg-shells. But I estimated the whole number of matured scales, containing no living and plump eggs, at several hundreds. After the above process had been gone through with, which necessarily obliterated or removed

many of the young Bark-lice killed by the soap, I counted 422 dead Bark-louse larvæ still adhering to the bark, *with the "anal sack" not at all developed,* and most of them without even a "medial scale," the great bulk of which must therefore have been killed by the soap while still in the larva state. If we assume that 22 of these were males—which is a rather large estimate—and deduct these from the total, we get 400 female bark-lice killed by the soap, to 7 that survived the operation of the soap; or, which is the same thing, out of the whole number of females 98¼ per cent. killed. It is possible however, though not at all probable, that the seven female Bark-lice that survived might have been late-hatched individuals, that crawled down, before they became stationary and after the soap was applied, from the small, terminal twigs that I neglected to soap. In this, as well as in the other three experiments already detailed, the portion of the branch examined under the lens was altogether too far removed from the main limb which was not soaped, to allow of any considerable number of Bark-lice crawling on to it from the main limb; and besides, when all these experiments were tried, the great bulk of the Bark-lice had certainly become stationary.

Dr. Mygatt tried the same experiment about the same time of the year, but used a much weaker solution of soap, which seems not to have been quite so effectual. "One tree," he informs us, "was treated with soap-suds, two tea-cupfuls of soft soap to a pail of water. Every part was wetted by immersing the ends of the branches and using a syringe. The leaves and young growth became yellow, but were not destroyed. A part of the lice were killed, probably half or more." (*Transactions Illinois State Agricultural Society,* I. p. 516.)

On November 7th, 1867, the scales being now of course fully matured, I made a still stronger solution of the same soap, namely one part by measure of soap to four parts of water, and applied it when warm with a very soft shaving brush to a branch prepared and labeled as in the other experiments. On December 5th, I cut off a portion of this limb and examined the scales under the lens. From some cause or other, upon this limb, which was upon a different part of the same tree and not so badly infested, the Mites had not operated at all, so far as I could discover. After lifting and examining several scores of scales, and finding that every one of them without exception contained good plump, healthy eggs, I became fully satisfied that the soap had not in anywise affected the vitality of the eggs, and did not think it worth while to continue the examination. The weather during the whole of November had been remarkably mild and genial and dry; and, from my experience with the eggs of this and

other insects, I am sure that, if these eggs had been killed by the soap, they would have shriveled up to nothing in much less than a month of such weather. But be this as it may, I shall be able to ascertain in the spring of 1868, from the portion of the branch that remains on the tree, whether these eggs that were soaped in November will hatch out as usual in the following spring, or whether some or all of them were killed by the soap.

From the above facts, I infer that soap will kill Bark-lice when they are very young, but has no effect whatever upon the matured scale.*

It is proper to add that, in all the above experiments that were tried in June, there was no rain for at least 6 days afterwards; and that in the November experiment there was no rain for several weeks afterwards. So that the various articles applied had a sufficient time for operating, before the rain washed them off.

STATEMENT 4th.—In April, 1866, I had an apple-tree, the lower limbs of which were infested, some of them pretty badly, by the Oyster-shell Bark-louse. I pruned them all quite closely, removing all wood under one-half inch in diameter, and then with a common painter's "sash-brush" painted them all over as thinly as possible with kerosene. Not many weeks afterwards I examined scores of the scales on these limbs, and found the eggs under all of them dead and dried up; and not a single Bark-louse, so far as I could discover, subsequently hatched out on them. Out of the whole number of limbs, but a single one died, and that was so completely covered with scales, that it would probably have died anyhow. The remainder put out fresh

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*Since the above was written, Dr. Mygatt has informed me that pure, undiluted soft soap is largely applied in his neighborhood to the matured scale, under the erroneous idea that it destroys the eggs. He has been kind enough to send me (February 29th) an infested twig soaped in this manner, and another twig cut off the very same limb which had not been soaped at all. On lifting and examining under the lens 100 scales upon each of these twigs, I found that on the *soaped* twig there were 31 scales containing plump, healthy eggs, and 69 scales, mostly gutted by the Mites, which contained no such eggs; while on the *unsoaped* twigs the numbers were respectively 30 and 70; showing that, where the soap had been applied, the number of healthy normal scales was actually one per cent. greater than where nature was left to her own devices. In this case the soap had been applied only 12 days before I lifted the scales; but in a specimen sent at the same time, to which the soap had been applied for considerably more than a month, there was a still larger proportion of healthy normal scales, namely, 37½ per cent. instead of 31 per cent. Hence, it may be inferred that even pure undiluted soft soap produces no effect upon the matured scale; although, as Dr. Mygatt informed me, "it kills all the foliage, fruit or young growth that it touches."

shoots, and are now alive and healthy. The tree was about 6 or 7 inches in diameter at the butt, and probably about one-tenth part of it was operated upon in this manner. In several other trees that I treated on the same system, the results were similar, it being uniformly only such branches as were completely coated over with scales, that subsequently perished.

Dr. Mygatt in 1854 gives the following testimony: "Lard was used on three bearing trees soon after the eggs hatched out; every insect touched with the lard perished; the limbs are now clear, except the spots missed. The trees grew finely, with no apparent injury to them. * * * I applied lard to several bearing trees in August; those scales are all dry and apparently dead, and no insects to be seen. * * * One tree, thickly covered with the white variety," [Harris's Bark-louse; see chap. 9] "was oiled over from the ground to the minutest branch. This was done in April; not an egg hatched. The new growth was luxuriant; and the tree is now clear of lice, and does not appear to be injured by the oil."—(*Transactions Illinois State Agricultural Society*, I. p. 516.)

In 1856, Dr. Fitch writes as follows: "Now at last it is pretty well ascertained, that anointing the trees with grease or oil is an effectual remedy [against the Oyster-shell Bark-louse.] I am assured of this by Dr. Hoy, of Racine, Wisconsin, and other correspondents, and by several communications in the *Prairie Farmer*, and other agricultural periodicals." (*New York Reports*, II. § 15).

Mr. Sherman, of Waukegan, Lake Co., Illinois, is reported in 1861 as using a mixture of equal quantities of linseed oil and tar, to destroy the Bark-louse in the perfect scale state. "These articles," it is stated, "are mixed over the fire by a gentle heat to dissolve the tar. The mixture is put on with a brush at any time during the winter or early spring, and has the appearance of a varnish. It has the advantage over the alkaline washes, used on the young insects, that it can be applied to all parts of the tree without the least injury to the shoots or buds, while it is death to the insect. His trees are nearly free of the insect, and have becomes vigorous and fruitful." (*Transactions Illinois State Agricultural Society*, V. p. 190.) The tar is probably inert here, except so far as it dilutes the oil, and it is in reality the linseed oil that kills the eggs.

In 1866 Mr. Cavanach, a market-gardener residing at Brooklyn, New York, said that he "had succeeded in destroying the scale-insect by the use of kerosene, without injury to the trees." (*New York Sem. Tribune*, March 16, 1866.) And subsequently he states as follows:—"We use kerosene regularly every year to kill the scale-insect

and other parasites upon our plants and trees without injury to them; and it has frequently been stated that crude petroleum has been used for the same purpose with good effects. Gas tar has proved injurious." (*Ibid.* March 30, 1866.) Two years afterwards the same man speaks in the following manner of petroleum:—"If any one wants to kill his trees, let him use petroleum; yet it is beneficial in a diluted state when applied to shrubs and plants to keep off insects, but it is death when applied to the roots." (*Ibid.* January 10, 1868.) Whether these observations are intended to apply to kerosene as well as to petroleum, is more than I can say.

At the Meeting of the Iowa State Horticultural Society, October 19, 1867, Mr. J. L. Budd, a fruit-grower residing at Shellsburg, Benton Co., Iowa, stated that he "had found 10 parts of benzine and 4 of soap the best remedy against Bark-lice." The benzine would in all probability be effectual at any time of the year; but, as I think I have shown, the soap would be useless, except early in the summer and except also by its diluting the strength of the benzine.

Finally, Dr. Pennington, of Sterling, Whiteside Co., Illinois, told me in 1867, that he had applied pure petroleum to the trunks of about 100 apple-trees infested by the Oyster-shell Bark-louse, and to about one-half of such of their limbs as were $1\frac{1}{2}$ inches and over in diameter; and that he can perceive no injurious effects. Before applying the petroleum, he pruned the trees well.

I think that there can be no doubt whatever, that petroleum, kerosene, benzine, lard, and generally any kind of animal or vegetable oil, will kill Bark-lice at any time of the year, though all kinds of watery infusions fail to have any effect upon the matured scale. The reason is obvious. The eggs under the scale can only be killed by some substance capable of reaching them through the protecting scale, which is glued too firmly and closely to the bark to allow of anything penetrating underneath it. Now, nature has made the scales *rain-tight;* but, as we have no showers of oil, she has not thought it necessary to make them *oil-tight.* Hence, oily substances will soak through the scale, and reach the culprit eggs; but watery infusions are incapable of doing this.

Whether some or all of these oily applications may not be more or less injurious to vegetable life, is a much more doubtful and disputable question. I saw an account in the *New York Tribune* several years ago, of a whole orchard being killed by applying "tanners' oil" to it, whatever that kind of oil may be. Perhaps it might have been applied in exorbitant quantities. Again: I have known a plum-tree killed by saturating a large cloth with kerosene, and wrapping it

round the butt, under the ridiculous idea that the Curculio could thus be prevented from getting at the plums. Again: Mr. Mitchell, of Pennsylvania, writes to the New York Farmers' Club, that having been advised in the Proceedings of that Club to apply kerosene with a feather to young cabbage plants, in order to keep off flea-beetles (*Haltica,*) he had tried it, and thereby killed 200 plants. (*New York Sem. Tribune,* June 26, 1866.) On the other hand, G. Goodsill, of McHenry Co., in North Illinois, asserts that he applied coal oil with a feather to young cabbage plants, in order to keep off flea-beetles, *Diabrotica vittata,* Fabr.,) without any injurious effects. (*Prairie Farmer,* April 1, 1865, p. 234.) Again: "W. T. W.," of Belleview, Iowa, says that he "lost one set of trees, some fifteen years since, by greasing them to keep off the rabbits, and would no more think of greasing fruit-trees than of chopping them down." (*Ibid.* January 6, 1866, p. 5.) And Mr. J. C. Plumb, of Madison, Wisconsin, asserts that he "has seen thousands of trees, from the nursery graft to the bearing size, ruined by greasy applications;" that if the trees are greased in winter, "the grease should be washed off by lye or soft soap in the spring," and that "the worst possible time to apply grease is in the winter; and the same amount which would cause death, if applied then, would be harmless if applied during the flow of sap in the growing season." On the other hand, "Young Sprout," of San Jose, says: "I have greased my trees for the last three winters with equal parts of lard and coal oil, and in the spring washed off with strong lye, and I have good thrifty trees." (*Ibid,* March 10, 1866, p. 151.) Lastly, which is the most important consideration of all, I find that there is a very general prejudice, both among practical and among theoretical men, against the application of oily substances to vegetable organisms. The subject is certainly a most difficult and important one, and the evidence rather contradictory; and it will require a series of carefully conducted experiments, which I hope to complete during the ensuing year, in order to arrive at any conclusive and satisfactory results. Probably benzine, as it evaporates more quickly and completely than kerosene (and, by the way, it is also much cheaper,) may be the least injurious of any of the oily applications; and perhaps all these oily substances may bear to be considerably diluted without losing their efficacy. Nothing but actual experiments, however, on an extensive scale can solve satisfactorily these and similar problems.

STATEMENT 5th.—In June, 1867, I used an old painter's brush, which had been worn to a stump, to scrub off the young newly-hatched Bark-lice from the larger limbs of an infested tree; and found it per-

fectly effectual. The lice fell before it as the grain falls before a reaping-machine.

STATEMENT 6th.—"An ounce of prevention is better than a pound of cure." When young apple-trees are purchased from the nursery, it will always pay well, in the northern parts of Illinois, to look them carefully over, and scrape off with a knife any scales of the Oyster-shell species that may be found on them. In the extreme southern parts of the State, this need not be done; for, as already shown, the Oyster-shell Bark-louse does not like the climate of that region and perishes if it is imported there. Recollect that every full-grown scale is a female full of eggs, and that the eggs average over 50 in number. There are absolutely no males in this crowd, to lessen the number of fruitful individuals. "Always plant a clean tree," is Dr. Mygatt's advice; and this advice of his is indisputably excellent. But unfortunately fruit-growers often wait till it is too late to fight the foe to advantage, and in the hurry and press of business the homely old adage is apt to be forgotten, that "a stitch in time saves nine."

Dr. James Weed, of Muscatine, Iowa, believes that this Bark-louse was almost entirely extirpated in his neighborhood by the intense cold—27 degrees below zero—of the winter of 1855—6. From the fact already twice stated, that it is a northern species, intolerant of a high summer temperature, I strongly incline to believe that there must be some mistake here. In the *Prairie Farmer* for October 29, 1864, J. C. Plumb, of Madison, Wisconsin, writes that the cold winter of 1863—4 had effected no diminution of the numbers of the Bark-lice, even in that high latitude.

As to what is a very current opinion amongst many of our most intelligent fruit-growers, namely, that it is only diseased, unhealthy, and badly-cultivated trees that suffer materially from Bark-lice, I am satisfied that this is an error. My own trees grow in garden soil, dug originally two spit deep, with a porous gravelly subsoil two or three feet below the surface, manured moderately every year with old thoroughly rotten cow manure, and cultivated through the summer; and the chief difficulty that I have with them is, that they grow too exuberantly and run too much to wood. Yet in spite of palliatives applied from time to time, and in spite of my little friends the Mites, the Bark-lice are steadily gaining on me; and unless I make a vigorous onslaught on them before long, they will probably in the end overrun all my trees. The truth seems to be, that, after a certain number of years, the Mites and Insects that prey upon the Bark-lice become so numerous as to check them up permanently. And thus we can account for the notorious fact that in those northern regions,

where only the Oyster-shell Bark-louse can thrive—as for example in Northern Illinois and Wisconsin—it is death upon apple-trees, for 6 or 8 years after it is introduced, but afterwards sobers down, and though still a grievous pest, becomes comparatively speaking, innocuous.

Before concluding this long chapter, I ought to caution the reader against a very prevalent, but a very delusive idea. People are perpetually reasoning upon the assumption, that any fluid substance, that they may apply to the limbs of a tree, is taken up by the sap and carried to the remotest twig; as if plants, like the higher animals, had a complete circulatory system of veins and arteries; whereas every botanist knows that it is no such thing. Whatever you apply to your tree to kill the Bark-lice, whether soapy solution or oily fluid, can only kill those insects that it actually touches, and will not be absorbed by the sap and carried unchanged to other parts, so as to kill the Bark-lice upon those parts. If it were otherwise, the apples on a tree that had been soaped would taste of soap, and those on a tree that had been treated with kerosene, would taste of kerosene. But that this is not so, every one may satisfy himself by an easy experiment, if he does not, as I do, know the fact already. Possibly, to a very limited extent, such substances as those referred to above may be absorbed by the cellular system of the tree; but even in that case they will undergo chemical changes which will totally unfit them for destroying insect life. To believe that pure kerosene, or pure soap, applied to one end of a tree, will pass in the very same chemical form to the other end of it, is as absurd as to believe that liquid manure can be taken up by the roots of a tomato-plant, and pass in that form and without any chemical change into the ripe tomatoes.

CHAPTER IX.—Harris's Bark-louse. (*Aspidiotus Harrisii*, Walsh.)

I have discussed the Natural History of the Oyster-shell Bark-louse at such exorbitant length, that it will not be either necessary or advisable to dilate upon that of this species, further than to point out the very remarkable characters in which it differs from the other.

1st. The difference in the shape and color of the scales, and in the color of the eggs, has been already explained. (See above, page 46.) The eggs hatch out at almost exactly the same date, (June 5th, 1867,) but, instead of the young larvæ being yellowish white, and soon afterwards becoming covered with a white powdery bloom, so as to form conspicuous although very minute white objects on the bark, they are blood-red at first and afterwards blood-brown, without any powdery bloom; and consequently, from their extreme minuteness

and from their being very sluggish in their movements, they can scarcely be seen on the bark with the naked eye. On June 12th, I observed some—which I identified as belonging to this species because they were still under the parent scale—to be of a pale blood-brown color, without any powdery bloom; they had the same longitudinal ridge and transverse grooves as the other species. The inexperienced eye, if it noticed them at all at this date on the bark, would be almost sure to confound them with the natural pores of the bark, which at first sight they greatly resemble.

2d. I have been unable to trace satisfactorily the history of Harris's Bark-louse from June to September, because the Oyster-shell species had invaded every one of my trees, that had been originally occupied exclusively by the native species; so that it was difficult to distinguish one kind of larva from the other kind. I could only ascertain one point clearly, namely, that the matured scale of the female, which is milk-white, is not formed till about the middle of September, and that the eggs are not developed under that scale till the end of September or some time in October; whereas, as we have seen, in the other species the matured female scale, which is the color of the bark, is formed, and the eggs fully developed, by the middle of August. Certainly, from the middle of June to about the middle of September, the females must remain of the same dark inconspicuous color as before; for the white scales, which are so conspicuous, appear all of a sudden on the bark in the middle of September. Dr. Houghton, of Philadelphia, as well as myself, noticed this fact. He has 20,000 pear-trees badly afflicted by this pest. "Up to September 15th," he says, "I flattered myself that there was not a living insect of this description in my orchard. I thought that the winter of 1865—6 had been so cold, that it had killed them all. But lo! on the 20th of September there were millions upon millions of Bark-lice on my pear-trees." (*Practical Entomologist*, II., p. 30.)

3d. On September 17th, or some weeks before any eggs were developed, I lifted up over 10 perfected female scales. Under each of them, and entirely separated from the scale itself, I found a legless, beakless, fleshy, elongate-oval Bark-louse, about 2½ times as long as wide, with its body divided into pretty distinct segments, the 3 first of which, and in a less degree the 2 next, were very much hunched laterally. The color was yellow, blood-red, or pink, and the length about 0.03 inch. One of these *I saw move very distinctly,* showing that it was really alive.

4th. The scale of this species is of a much more delicate consistence than that of the Imported Bark-louse, and it rarely remains un-

broken on the bark after the eggs hatch out, but is generally either more or less mutilated or entirely removed by the weather. The empty egg-shells are white, as in the other species.

5th. The empty scales, which are supposed by Harris to have produced males, may be found in considerable numbers in the autumn loosely attached to the bark or some of them scarcely attached at all. Towards the spring they are generally most of them washed off by the weather. As these never occur on trees infested exclusively by the Oyster-shell species, they cannot belong to that species; and I therefore, by the method of exhaustion, infer them to belong to Harris's Bark-louse. They are oblong-oval in shape, of a pure white color, with the usual yellowish "larval scale" attached at one end, the remaining portion having its sides perfectly parallel, and being as wide as the "larval scale" is long, and in length from 2 to 2½ times as long as the "larval scale." There is no "medial scale," behind the "larval scale," as there always is in the matured female scale of every species of this genus known to me. I have never actually bred the males from this type of scale, neither, as it seems, did Harris; but I have now little doubt that Harris's opinion is the correct one, and that I was entirely mistaken when I formerly imagined, that these empty scales were the cast skins of the immature females. (*Practical Entomologist,* II. p. 32.)

As to the geographical distribution of Harris's Bark-louse, Harris found it, but apparently only in small numbers, in Massachusetts. Dr. Houghton is pestered with it awfully in Pennsylvania, and Dr. A. Chandler, Montgomery Co., Maryland, must also have it in abundance; for he says that his pear-trees "have stopped growing and are covered with *white* lice, which when mashed with the point of a knife, discharge a *red* fluid." (*New York Sem. Tribune,* March 26, 1867.) I have myself seen specimens near Cobden, South Illinois, some of which occurred on the European Mountain Ash (*Sorbus aucuparia,*) a tree which Dr. Asa Gray places in the same genus as the Pear and the Apple. I have likewise received specimens from the orchard of W. C. Flagg, near Alton, in South Illinois. And it must occur in St. Clair Co., also, in South Illinois; for at a Meeting of the Alton Horticultural Society, May 2, 1867, President Pearson reported that he had found "upon trees purchased in St. Clair County, Bark-lice or Scale-insects containing eggs, which when broken gave out a *red-colored* juice." Dr. Mygatt mentions it, under the appellation of the "white variety" of the Oyster-shell species, as common in Kane and McHenry Counties in North Illinois, and I have long found it pretty abundantly in Rock Island County, both on apple-trees and on the crab. Lastly Bark-lice, which, as it would seem, can only belong to this species, are reported from Hartville, Wright Co., Missouri, which is nearly in the

latitude of the extreme southern point of Illinois, as "utterly destroying the best apple-orchards in that county, starting on the trunks of the trees, spreading rapidly on the branches, and then on the apples—killing large trees in two years." (*Rural World,* October 15, 1866.) I heard no complaints of this insect being at present at all troublesome near Cobden, South Illinois; but at some future day it may likely enough make an irruption upon the pear orchards of Southern Illinois in full force.

I observe that on all my apple-trees, which were infested a year or two ago by Harris's Bark-louse, this native species is being gradually supplanted by the improved and highly-developed species from the other side of the Atlantic; just as the White Man is supplanting the Red Man in America, or as in New Zealand the European House-fly (*Musca domestica,* Linnæus) and the Brown Norway Rat (*Mus decumanus,* Linnæus) are driving out the Native Fly and the Native Rat. (See Spencer's *Principles of Biology,* I, p. 389.) It is preyed on by the same Mites as the other kind, and, being so closely allied to it, must be attacked on the same principles and with the same weapons.

INSECTS INFESTING THE APPLE.—On the Root.

CHAPTER X.—The Apple-root Plant-louse, (*Pemphigus pyri,* Fitch,) commonly but incorrectly called in Illinois "The Woolly Aphis."

This insect has been very generally confounded with the true "Woolly Plant-louse" or "Woolly Aphis" (*Eriosoma lanigera,* Hausmann), which, so far as is known at present, occurs only on the Atlantic seaboard, though it may perhaps eventually work its way Westward into the Northern parts of the Valley of the Mississippi. It is very true that both insects are "woolly," inasmuch as they both secrete a woolly or cottony substance from the general surface of their bodies, and both are "Plant-lice," inasmuch as they both belong to the *Aphis* family; but they differ in their native country, they differ in the structure of their wing-veins and consequently in the genus to which they are referable, and they differ very widely in their habits.

The true "Woolly Plant-louse" is an imported insect, having been in reality introduced into America from Europe though, singularly enough, it was misnamed in England "the American Blight," when it was first noticed in that country towards the close of the last century, and was erroneously supposed to have been introduced there from America. It is now, however, pretty clearly ascertained to have existed on the continent of Europe for time immemorial, and it probably

emigrated thence into England on imported apple-trees.* The Apple-root Plant-louse, on the contrary, is a native American species, and in all probability infested our wild Crabs and Thorns in the olden time, and, when apple-trees were introduced here, saw fit to attack them also.

In the typical or normal Plant-louse there are in the front wing three branch-veins, springing successively out of the main or rib-vein which coasts along the outer or anterior edge of the front wing. In the genus to which the Apple-root Plant-louse belongs (*Pemphigus*), the 3d of these branch-veins is *perfectly simple;* in the genus to which the true "Woolly Plant-louse" belongs (*Eriosoma,* otherwise known as *Schizoneura* or *Myzoxylus*), the 3d of these branch-veins is *once-forked;* in the genus to which the common Apple-tree Plant-louse belongs, (*Aphis,*) the 3d of these branch-veins is *twice-forked.* Thus, on the very same Apple-tree, may be found examples of all these three genera—namely, the Apple-root Plant-louse, the true Woolly Plant-louse and the common Apple-tree Plant-louse—all distinct from each other by a very obvious character, and only in very rare and exceptional individuals of any of them running together by intermediate grades.

Harris indeed, on the authority of Hausmann and Knapp, asserts that the true "Woolly Plant-louse" never has any wings at all.† But Amyot and Serville describe the male as winged, (*Hemipt.* p. 612); Westwood describes both sexes as winged, though he confounds the genera (*Pemphigus* and *Eriosoma*) together, (*Introd.* II. p. 440 and *Synops.* p. 118); and lastly Mr. A. E. Verrill discovered in Connecticut in October numerous winged specimens, both of the males and of the females. (*Practical Entomologist,* I. p. 21.)

The true "Woolly Plant-louse" is a northern species, and according to the European entomologist, Blot, cannot stand a hot climate even in its native country, Europe, being confined to Belgium, the north of France, Germany and England. Hence, so far, it has occurred in this country almost exclusively in New England. The Apple-root Plant-louse, on the other hand, seems to be far more destructive in a hot southern climate than it is towards the north. Again: the true "Woolly Plant-louse" never burrows underground to get at the roots, but inhabits exclusively the trunk and limbs of the Apple-tree, where it secretes large masses of cottony down. The Apple-root Plant-louse, on the contrary, lives habitually underground, sucking the sap from the roots and causing thereon large excrescences and swellings, among which it secretes a bluish-white downy substance,

*See Harris's *Injurious Insects,* p. 242, and Amyot and Serville's *Hemiptera,* p. 606.

†See Harris's *Injurious Insects,* p. 243.

which, at first sight, has much the appearance of mouldiness. It is, doubtless, true that, according to Dr. E. S. Hull, of Alton, South Illinois, "it crawls upon the branches of the trees, during the summer, and is distributed broadcast through the orchard by the force of the winds, retiring underground and congregating about the roots on the approach of cold weather;" (*Agr. Rep. Mo., Append.*, p. 451;) and that, as Wm. Carpenter, of Cobden, South Illinois, informed me, "it occurs in young trees in the nursery, two or three feet from the ground, but only," as he thought, "in damp weather." But I myself saw three or four wingless specimens, subsequently taken by Mr. Carpenter off the trunk of a good-sized apple-tree during the long drought of the autumn of 1857, which I carefully compared with similar specimens captured by myself on the roots, and found to be identical. Moreover, in December of the same year, Mr. W. C. Flagg, of Alton, South Illinois, sent me, alive and in excellent order, quite a number of specimens, gathered at that unseasonable period off the trunks of good-sized apple-trees, which, on the most careful comparison, differed in no respect from the root-feeding individuals. Mr. Flagg, however, informed me that "it is found more generally on the surface of the ground, where there has been straw or some such substance heaped around the tree." Still, all such cases as these are evidently the exception, and not the rule; and there can be little doubt that the great bulk of this species live underground, and that it is on the roots that they are to be dreaded, and on the roots that they are to be fought.

As long ago as 1848, Mr. Fulton, of Chester Co., Pennsylvania, found this insect and the knotty swellings produced by it to be so abundant on nursery trees in his neighborhood, that thousands of young trees had to be thrown away, and it became difficult to supply the market. (Downing's *Horticulturist,* III., p. 394.) M. L. Dunlap ("Rural"), in a letter to the *Chicago Tribune,* (in August 1858,) writes nearly as follows:—"In the orchard of Dr. Long, near Alton, the 'Woolly Aphis' infests the roots in immense numbers, and by sucking up the sap destroys the trees, which in its effect has much the appearance of dry rot. Dr. Long erroneously attributes the death of his trees to water standing about the roots." Mr. Jordan, one of the St. Louis nurserymen, informs me that at this present day he is greatly troubled with it on his land, so that he finds it difficult to get enough of clean roots to graft with. According to Dr. Hull, "it is one of the worst enemies against which our apple-trees have to contend, and is much more common in our region than is generally supposed." (*Agr. Rep. Mo. Append.* p. 451.) In the summer of 1867

Mr. O. B. Galusha, as one of the *ad interim* committee of the Illinois State Horticultural Society, visited Cobden, South Illinois, and collected large quantities of the roots infested by this Plant-louse, which he transmitted to Mr. C. V. Riley for examination, expressing the opinion, at the same time, that "the destruction of the apple-orchards, in this vicinity, by this insect, or by the fungus that accompanies its operations, seems inevitable, unless a remedy is soon discovered." (*Prairie Farmer,* June, 1867, p. 397.) When I was at Cobden myself, in November, 1867, I personally examined the orchard of Mr. Paul Wright, and found that small groups of apple-trees had been killed by this Plant-louse in several directions, some of them having perished with the half-matured fruit still hanging on their boughs. In one spot of ground no less than nine trees, all in one square patch, had been killed by it; and separated therefrom by only a single row of living trees, there were two or three more dead trees. Digging down to the roots of the live trees, that intervened between these two gaps in the orchard, I found at once great numbers of the enemy—none of them, however, in the winged state—and also abundance of roots, clubbed, knotted and distorted, in almost every imaginable form, by their punctures. On examining the trees, that had been killed, several months previously in the summer, I found that their roots were now completely rotted, so that nothing remained of them but a few short snags attached to the butt, and the first high wind that came would necessarily blow the tree over. On the dead and decayed roots of such trees, I found, of course, no Root-lice; but Mr. Wright assured me that they were to be met with on the roots in great numbers in the summer, when the trees first began to droop and wither. Among the living roots on which I had found living Root-lice, there were a few roots as completely dead and rotten as those of the dead trees.

At first I imagined that every tree must have been infected, when it was originally received from the nursery. But Mr. Carpenter subsequently informed me, that he had found the insect in abundance on the roots of seedling apple-trees, in the autumn following the spring when the seed was sown; and another fruit-grower told me, that he had seen it on the roots of seedling apple-trees, when no other apple-trees were within 200 yards, and on land lately reclaimed from the forest. Clearly, therefore, the insect must pass from tree to tree, either in the winged form which Dr. Fitch found it to assume in October, in the State of New York, or by some of the wingless individuals, that inhabit the trunk or limbs, being blown to and fro by the winds through the instrumentality of the light, feathery down, which exudes from their bodies. Probably the species has always

existed on the roots of certain forest-trees in this whole region of country; and when apple-orchards began to be planted, it emigrated on to the apple-trees.

This rotting away of the roots, which, as it appears, had been noticed as long ago as 1858 by Mr. Dunlap, and attributed to its true cause, is popularly known in South Illinois as "rotten-root," and was, at one time, considered as a mere natural decay, superinduced by the system of root-grafting now so very generally adopted in the West; while, as we have seen, Dr. Long, of Alton, attributed it to the operation of stagnant water on the roots.* The "Early Harvest" apple is said to be peculiarly subject to this mortal malady. Similar cases, where insects give the preference to one particular variety, or avoid one particular variety of a cultivated plant, are common in Economic Entomology. For example, the Colorado Potato-bug (*Doryphora 10-lineata,* Say) is known to avoid the Peach-blow Potato, and, as has been already shown, (above, page 28), the Rose-bug prefers the Clinton to all other grape-vines.

But although the more southern parts of Illinois are far worse afflicted by this insect than the northern counties, yet it exists and does considerable damage even in North Illinois. Mr. Kinney, the Rock Island nurseryman, informs me that he has often noticed a woolly louse, which can be nothing else but this species, on the roots of his young apple-trees, along with just such knots and swellings as it usually produces elsewhere, and he has himself lost four or five bearing apple-trees, and knows of 20 or 25 others that have been lost by his neighbors, through what, from his description, must be the same "rotten-root" that prevails so extensively in South Illinois. Mr. L. Woodard, nurseryman, of McHenry Co., North Illinois, also told me, that he had occasionally noticed a few woolly lice on the roots of his

*Mr. Riley informs me that apple-trees, and more especially those that are young, sometimes die in South Illinois "with their roots ENTIRE and discolored throughout from the surface-mark downwards," but with "no trace of any insect whatever;" and that this very distinct disease is "known in the West and by Warder, Flagg and others as 'Rotten-root.'" I am quite confident that the dead trees, with their roots almost entirely rotten, in Mr. Wright's orchard were killed by the Root-louse; and the peculiar appearance which they presented has been already described, so that it can be recognized with facility. But I by no means wish to be understood as asserting, that every apple-tree that dies in South Illinois dies of the Root-louse. Perhaps, under the popular name of "Rotten-root," two very distinct affections of the roots of the Apple-tree have been confounded together, the one caused by the Root-louse and the other arising from unknown causes. I hope to investigate this question more fully during the coming season.

young apple-trees accompanied by the usual deformation of the root. Mr. Ira L. Bailey, President of the Carroll County Horticultural Society, North Illinois, likewise informed me that he had himself lost three large apple-trees by the same universal "rotten-root." And finally I heard that Dr. Pennington, the extensive fruit-grower of Whiteside Co., North Illinois, had sometimes noticed "woolly plant-lice" on the limbs of his apple-trees, but not in any considerable numbers. Hence there is pretty satisfactory evidence that this insect exists, though apparently in greatly reduced numbers, up to the most northerly parts of the State.

I found it to be a very general notion at Cobden, that the soil there was full of this Root-louse—that it existed in earth that contained no roots at all and in old rotten stumps—and that it was abundant on the roots of almost all forest-trees, especially on those of the Persimmon (*Diospyros virginiana*). No plant-louse, however, can possibly live, except on the sap of some living and growing plant; and therefore, if any of these Root-lice are found in old dead stumps, etc., they must, for purposes which will be afterwards explained, have been carried there by the ants; as I have ascertained to be actually the case with certain other species of the very same genus. That there is a Plant-louse infesting the roots of the Persimmon in that neighborhood, I fully believe; because, on digging down among the roots of that tree, Mr. Riley and myself discovered the peculiar bluish-white mould, which is characteristic of Root-lice, though we failed to find the insect itself. But it is impossible that this can be the same species as infests the Apple-tree, because the Persimmon and the Apple-tree, belong to widely distinct botanical families; and it is a rule to which there is not one solitary exception, that, when a particular species of Plant-lice infests more than one species of plants, those species of plants always belong to the same botanical family, and usually to the same botanical genus. For the same reason, if any Root Plant-lice are found on Oak, Beech, Ash, Mulberry, Sassafras, Tulip-tree (Poplar,) Cucumber-tree, Elm, Hickory, Walnut, Birch, Poplar (Cottonwood, etc.,) Hackberry, Sumac, Dogwood, Grape-vine, Sycamore (Plane-tree,) Hazel, Basswood, Maple, etc., they cannot possibly belong to the same species as infests the Apple-tree, and, if transferred to the roots of the Apple-tree, they would soon starve to death and perish. On the other hand, it is highly probable, that the very same species, that infests the roots of the Apple-tree, infests also the roots of the Crab and the Thorn; and it may possibly occur on those of the Plum, the Cherry and the Peach, and even on those of the Blackberry and the Raspberry; for all these last named plants

belong to the same botanical family as the Apple-tree. It is observable, however, that although Apple-trees and Peach-trees are commonly grown in the same orchard near Cobden, yet I did not hear of a single case, where the roots or bark of the Peach-tree had been found to be infested by this insect, or any other at all resembling it.

Persons, who are not familiar with the habits and classification of Insects, are apt to think that all Plant-lice—different as some of them are in shape, color, size and habits—are mere varieties of one and the same species; just as all dogs, however much they may differ from one another in such respects, yet belong to one and the same species. But it is by no means so. Whatever food one variety of Dog will live on, another variety of Dog will live on equally well. But shift the Apple-tree Plant-louse on to a Cherry-tree, or the Cherry-tree Plant-louse on to a Plum-tree, or the Plum-tree Plant-louse on to a Peach-tree, and it will before many days die of starvation. Yet these trees all belong to the same botanical Family. Dr. Fitch has remarked that the imported species of Plant-louse, that inhabits the tame Cherry-tree, cannot live even upon any of our wild Cherry-trees, and that even the wild Black Cherry (*Cerasus serotina*) and the Choke-cherry (*Cerasus virginiana*), closely related as they are, are inhabited by distinct species. (*N. Y. Rep.* I. p. 131.) Again: the Currant and the Gooseberry belong to the same genus. The Currant is notoriously infested by a Plant-louse (*Aphis ribis,* Linnæus) which has been imported along with that shrub from Europe. Yet, although these two plants are often grown in gardens side by side, nobody ever saw any plant-lice of any kind on the Gooseberry, much less the true Currant Plant-louse. Yet, if the same species of Plant-louse can feed almost indiscriminately upon any kind of plant, why does not the Currant Plant-louse emigrate on to the Gooseberry? I have myself observed that different species of Plant-lice (*Aphis*) inhabit different species of Oak; for example, the Handsome Plant-louse (*Aphis bella,* Walsh) is peculiar to the Black Oak, (*Quercus tinctoria,*) where, since I described the species, I have found it in abundance in company with its larva; and an undescribed species of the same genus, with remarkably stout branch-veins to its front wings, is peculiar to the Swamp White Oak, (*Quercus prinus,* var. *discolor.*)

As regards the Root Plant-lice, we know but very little of the species found in this country, because, like other underground insects, they are hidden from our observation in the bowels of the earth. Indeed, besides the species now under discussion, the only other described North American species are two, which I myself was the first

to discover and describe in the winged state, and which I found to be carried home by certain Ants to the nests inhabited by the young larvæ of these Ants, for the sake of the sweet, woolly matter secreted by them, and thence carried back again to the roots on which they fed—just as a dairyman drives his cows up to be milked and then drives them back again to pasture.* Both these species are quite distinct from the Apple-root Plant-louse; and I am acquainted with several others, but only in the wingless state, which are also quite distinct from that insect. As to the true "Woolly Plant-louse" of the Apple-tree, the European entomologist Blot says, that "it can only live upon the Apple-tree, and if transplanted upon any other tree, it very soon perishes. (Amyot and Serv., *Hemipt.*, p. 610.)

What is probably THE WINGLESS FEMALE FORM of this APPLE-ROOT PLANT-LOUSE measures, when fully grown, about 0.07 inch long, at which time, after removing the white down, it is of a dull lead color. The antennæ are indistinctly 6-jointed, with the length of the joints proportioned nearly as 2, 2, 4, 2, 2, 3, the last joint including a short terminal seta (*unguiculus*). The beak extends to the base of the middle legs.

The color of THE YOUNG LARVA is dull yellowish, as described by Fitch. The antennæ are indistinctly 5-jointed, the joints nearly equal, joint 3 a little the longest, and 5 with a minute terminal seta. When the larva is very young indeed, the beak is longer than the body, and projects behind so as to resemble at first sight, the honey-tube of the genus *Aphis* and its allies. When older, the beak is about two-thirds as long as the body.

I have not yet obtained THE WINGED FORM OF THE FEMALE; but a full description of it is given by Fitch. It occurred in New York on October 29th. (*N. Y. Rep.* I. pp. 9—10.)

After a group of these lice has been stationed on a root in the open air for two or three days, they become completely enveloped in a white cottony mass, the filaments of which are five or six times as long as the insects themselves, and, though somewhat crinkled and irregular, radiate in general from the body of the insect as from a centre. Attached to this mass may almost always be seen one or two globules of sap, such as we often meet with rolling about among the powdery matter secreted by the plant-lice that inhabit "Galls." Dr. Fitch figures and describes the cottony matter as protruding only from the tip of the abdomen of the larva; (*N. Y. Rep.* I. p. 9;) but in reality it proceeds in an infinity of very fine filaments from the general upper surface of the insect, though perhaps, as stated by Mr. Riley, it is secreted rather more densely on the hinder portion of the back. Most certainly it is not secreted exclusively either from the

*See Proc. Ent. Soc. Phil. I. pp. 307—8; and Trans. Ill. State Agr. Soc. V. pp. 493—4.

mouth or from the tail; for I have had hundreds of these lice sucking away at apple-roots in a glass vase for a month, and have thus been enabled carefully to study the mode in which the cottony matter is produced. So far as regards the winged insect, Dr. Fitch expressly says that "the head and the abdomen on its back are covered with a dense mass of flocculent down;" (*ibid.;*) and Dr. Harris, speaking of the larva of the true Woolly Plant-louse, says that the cottony down "seems to issue from all the pores of the skin of the abdomen." (*Inj. Ins.* p. 243.)

Dr. A. S. Packard, junr., of Maine, has published some very amusing and sprightly banter, in ridicule of my theory, that the cocoon of all Gall-gnats (*Cecidomyia*) is *exuded from the general surface of their bodies,* not, as in the case of Caterpillars, etc., *spun from the mouth,* which this author maintains to be the true theory in the case of Gall-gnats. If he had given himself the trouble to read the paragraphs which he undertakes to criticise, he would have seen that, in the case of two distinct species of Gall-gnats, the fact of the cocoon being *exuded* and not *spun* has been proved by actual observation by Winnertz and by Osten-Sacken.* And as to his disbelief in the possibility of any cocoon being exuded from the general surface of the body, if he had ever examined with his own eyes any of these Woolly root-feeding Plant-lice, he would have seen at once that the woolly matter is not secreted from the mouth, nor even from the tail, but from the general surface of the body. Many other larvæ do the same thing. On May 25th I found in a nest of Yellow Ants (*Formica aphidicola,* Walsh,) situated in the decayed stump of a Honey-locust several remarkable woolly larvæ, which a month afterwards produced a species of Ladybird (*Hyperaspis punctata,* Melsh.) These larvæ were covered on the back with dense white cottony down, precisely like that of root-lice; on removing some of which *lightly* with a moist camel's hair pencil, little globules of a yellowish fluid started out from the skin of the larva, evidently from the same pores from which the cottony down had previously exuded. This is the only genus of Ladybirds (*Coccinella* family) known to me, the larvæ of which exude matter of this precise description from their bodies; but it was long ago discovered that in another genus (*Scymnus*) the larvæ have their bodies garnished with whitish cottony tufts; and on examination it will be found that these tufts also are mere secretions from the pores of the body, and not organized appendages like the hairs of a caterpillar or the scales on the wings of a butterfly. The bluish white

*Compare my Paper *Proc. Ent. Soc. Phil.* III. pp. 560, 562 and Dr. Packard's paper *ibid.* VI. pp. 214—5.

powdery matter, which is well known to form gradually on the outside of the bodies of certain male Dragon-flies (*Libellula* and *Agrion* families) as they approach maturity, and also on those of several other insects belonging to other Families and Orders, for instance the so-called Locusts (*Cicada* family,) must manifestly be produced on similar principles. And, as we have seen in the case of the larva of the common Oyster-shell Bark-louse, the powdery bloom and the cottony floss, spoken of above, are met with at the very same time and in the very same insect; both of them proceeding, not from the mouth nor even from the tail, but from the general surface of the body.

It is scarcely worth while, however, to argue such points as these with a writer, who is actually so ill-informed as to assert that "everybody knows that the silk spun by insects is exuded through the mouth." (*Dr. Packard's Paper*, p. 214.) It is very true that it is so in the case of caterpillars, etc.; but in the case of the Ant-lions (*Myrmeleon*,) the Caddice-flies (*Phryganea*,) the Lacewing-flies (*Chrysopa*,) and probably of all true Neuroptera, as distinguished from the Pseudo-neuroptera, everybody knows, or ought to know, that it is "exuded," not from the mouth, but from the tail.* Moreover, all the spiders without exception—which group of Articulate Animals Dr. Packard, in common with the school to which he belongs, classifies as Insects—also spin from spinnerets placed, not in their mouths, but in their tails. Yet, because this writer had happened perhaps, one or twice in his life, to see a caterpillar spin from its mouth, he jumps to the conclusion—with the same propensity for sweeping generalizations that characterizes everything that he has published—that all insects without exception spin from the mouth! ! !

From the enormous rate at which all Plant-lice multiply, it is plain that, if there were no check upon the increase of this species, it would, in a few years' time, destroy every apple-tree in South Illinois. But, in all probability, there does exist one such check, at all events. Right in the middle of a little colony of these Root-lice I discovered in November the pupa of what I am pretty sure is a *Syrphus* Fly; and Mr. Riley, to whom I showed the specimen, told me that he had formerly found great numbers of the larva of the same species among the infested roots—that he had reared it to the pupa state—but that he could never succeed in breeding it to the winged state. Apparently, this is the same insect, which, in the *Prairie Farmer* of June 15th, 1867, that gentleman mentions as, "having been always found by him

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*See Kirby & Spence's *Introduction*, letter 13th, end; letter 21st, near the end; Fitch, *N. Y. Rep.* I. p. 79; Shimer *Proc. Ent. Soc. Phil.* IV. p. 210.

in conjunction with this Root-louse, though he had failed to breed it," and which he there describes as "a footless maggot five or six times as large as the Root-louse, and of a dirty yellow color, attenuated at both ends, the head being quite retractile;" and which he afterwards pronounces to be "doubtless the larva of a *Cecidomyia*, the same Family to which the Hessian Fly belongs," and to "take some part, probably, in inducing the deformities of the roots." But certainly the insect that I showed to Mr. Riley does not even belong to the same great group of the Two-winged Flies as the Gall-gnats (*Cecidomyia*,) inasmuch as it has what is called a "coarctate" pupa; (see above p. 39;) and I feel pretty confident that it will prove to be the Cannibal appointed by Nature to prey upon these unruly root-feeders, and keep them within reasonable bounds. The *Syrphus* family, however, to which it apparently belongs, includes many genera, which, in the preparatory states, can scarcely be distinguished from each other, and some of which feed upon decaying animal and vegetable substances, (*Xylota*, etc.,) while others (*Syrphus, Scæva, Volucella*, etc.,) are Cannibals and feed upon other insects. In any case I hope before next summer is over, to solve the mystery definitively, by rearing the winged Fly from the pupa which I found. If, as I confidently anticipate, it should prove to belong to one of the Cannibal genera of the *Syrphus* family, the reason why Mr. Riley failed to breed it becomes manifest at once. He supposed it to feed upon vegetable matter, and therefore his specimens, being, in all probability, not supplied with a due allowance of their natural diet—the Root-lice—perished of starvation. Such accidents often happen to the most experienced breeders of larvæ; and, moreover, almost all Cannibal larvæ are much harder to breed than plant-feeding larvæ.

In quoting what I believe to be a mistake made by Mr. Riley in regard to the above larva, I intend no disrespect whatever to that industrious and intelligent entomologist. There is not an entomologist, living or dead, in any country of the known world, who has not, at one time or another, made such mistakes; and I am not ashamed to confess, that I have repeatedly myself blundered in the same manner. For example, I once took the dead and dried-up larva of a small Gall-gnat (*Cecidomyia*) for the larva of a Gall-Fly (*Cynips;*) but, as soon as I discovered my error, I embraced the earliest opportunity of acknowledging it in print. And here lies the difference between the men that write for victory and the men that write for truth. The latter frankly confess their errors as soon as they become aware of them; the former claim to be infallible, and never will allow that they have been in the wrong. I could name an entomologist of deservedly high

standing in America, who has published, within the last twenty-five years, several volumes about insects, and has therefore, of course, made several mistakes in the course of his scientific career which have been from time to time corrected by other entomologists in print. Yet, from one end to the other of his works, no man can point out a single passage, where he has ever acknowledged himself to have been in the wrong. Like the horse-jockey in the old story, having once said that the horse was 16 *feet,* not 16 *hands* high, he will never go back on his word.

As to remedies against this insidious little pest, I believe that the cheapest and best one will be to drench the roots of infested trees with boiling water. Mr. C. T. Farrell, of Cobden, informed me that he had tried this prescription—which was originally recommended by Mr. Riley—and that he had found it effectual. Ashes, which have been advised to be used by Dr. Fitch, he found of no use; but a strong wash of soap and water proved to be generally, though not always, effectual. Other gentlemen had found the free application of unleached ashes injurious to their trees. There need be no apprehension that hot water, when applied to the roots, will kill or injure the tree; for it has been extensively used without any ill effects to kill the borer in peach-trees, and to kill the maggots in young growing onions. Indeed, it is a very general law that vegetable organisms will, for a short time, stand a much higher temperature than animal organisms, without any injury to their tissues; and, in certain cases, boiling water seems actually to stimulate the vitality of seeds, instead of impairing it. For it is well known that neither Locust seeds (*Robinia*) nor Honey-locust seeds (*Gleditschia*) will grow the first year, unless they are scalded, and that, if they are scalded, they germinate as freely as Maize. As regards Honey-locust seeds, I am assured of the truth of this fact by Mr. Whitney, of Lee Co., in North Illinois.

Before young apple-trees, especially those raised in the Southern part of the State, are planted, the roots should always be soaked a considerable time, either in a strong solution of soap, or in strong tobacco-water—the latter would probably be the more effectual of the two. Thus, if the insect is not already in the vicinity, it may be prevented, perhaps, for a long series of years, from getting there; for whatever root-lice may exist on the roots of the young trees, will, by this means, be effectually destroyed before these young trees go into the ground.

INSECTS INFESTING THE PLUM.—On the Fruit.

CHAPTER XI.—The Plum Curculio. (*Conotrachelus nenuphar*, Herbst.)

In the *Practical Entomologist* (Vol. II. pp. 75—79) I have dilated so fully on the Natural History of this pestilent little Snout-beetle, and on the most approved methods of fighting it, that it will only be necessary to add a few items here on these two subjects, and to correct such errors as I have fallen into.

Although the Curculio now infests the cultivated species of Plum (*Prunus domestica,* Linnæus,) to fully as great an extent as our common wild species (*Prunus americana,*) yet it is only at a comparatively recent date that it attacked our cultivated Plums, and since that epoch it has been growing every year worse and worse, and making onslaughts upon other fruits such as the Peach, the Cherry, and even the Apple. "Curculios," said the Hon. D. J. Baker, in 1855, "were unknown and never made their incursion into this region, until some years after the organization of our State Government," A. D. 1818. (*Transactions Illinois State Agricultural Society,* II. p. 48.) There can be little doubt, however, that Curculios have existed for time immemorial in our State, breeding in wild plums; because, before tame plums and peaches and apricots were imported into this country from Europe, the insect must necessarily have bred in the wild plum, and wild plums are very abundant in Illinois, and moreover we know, from our present experience, that the climate of Illinois is quite congenial to the constitution of this insect. It would certainly, therefore, seem to follow that, in this as in so many other cases, when an insect has incidentally acquired a habit of feeding indiscriminately upon a different species of plants, to that upon which alone it naturally fed in the first instance, it transmits that habit by the laws of inheritance to its immediate descendants. When a race has once been formed, having such a habit, nothing seems more natural than that, under certain peculiar circumstances, such for instance as the absence of the original food-plant, another race should be very slowly and gradually formed, which exclusively attacks the new food-plant. If we suppose this second race to interbreed exclusively with itself, and to have thereby acquired, in a long series of ages, either a moral indisposition or a physical incapacity to interbreed with individuals belonging to the original race, then it becomes almost as effectually isolated from the original race, as if it were separated therefrom by the Atlantic Ocean, or by such an insurmountable barrier as the Rocky Mountains. Now, we know that races of insects, and indeed of other animals as well, when separated from each other

by such physical barriers, often run into what are technically termed "geographical races;" that is, come to differ constantly from each other in more or less slight peculiarities of size, form, or color. Hence it is but reasonable to suppose, that distinct races of some particular insect, inhabiting the same geographical area, but feeding upon distinct plants and never interbreeding with each other, should also, in a long series of ages, come to differ from one another in size, form, or color. Such distinct races I have proved to have an actual existence in numerous cases, and have given them the name of "Phytophagic Species."*

I by no means infer that, in the case of the Snout-beetle that infests our Plums, our Peaches, our Cherries and our Apricots, such a phenomenon has as yet occurred, and that the plum-feeding form is a different species from the cherry-feeding form, and that again from the peach-feeding form, and so on. There is no reason whatever to think so. But there actually, in my opinion, does exist a "Phytophagic species" of the common Curculio, which is uniformly one-half larger and which in the larva state feeds, not upon stone-fruit or pip-fruit, but upon green Butternuts and Walnuts (*Juglans,*) from the former of which I bred two individuals August 13th. Of this peculiar type of Curculio I sent specimens 6 years ago to our great North American authority in the Order of Beetles, Dr. J. L. LeConte; and he pronounced them to be mere varieties of the Plum Curculio. They scarcely differ from that insect in any other perfectly constant character than size;† and at first sight we might suppose, that the increased size was caused merely by the Butternuts and Walnuts being more nourishing and stimulating food than Plums and Peaches; and

*See my Papers on this subject in the *Proceedings of the Entomological Society of Philadelphia*, Vol. III. pp. 403—430 and Vol. V. pp. 194—216.

†There is, I believe, a slight, but perfectly constant colorational character by which these two forms are distinguishable. The broad band behind the polished black humps on the wing-cases is, in the large-sized nut-inhabiting form, of a dingy white color with a few milk-white spots. In the small plum-inhabiting form, this same band is of a bright ochre-yellow color, with more or less milk-white spots, which last, however, never occupy more than one-half of the ochre-yellow band. Moreover, I am informed by Dr. Hull, that the larva of the large-sized form—with which he has long been familiar—occurs with him in hickory-nuts having their shucks marked by the characteristic crescent-slit, and that this larva "penetrates to the kernel of the nut." Whereas, as is well known, the larva of the small-sized form that frequents the plum, never under any circumstances penetrates to the kernel of that fruit. This difference in the habits of the two forms, is certainly very remarkable.

that a Curculio bred in a Butternut would be just as likely as not to lay its eggs in a Plum, and the reverse; thus showing that here no distinct "Phytophagic species" has yet been formed. This was the opinion of Dr. Fitch; for he says that "the specimens found on Butternut trees are always larger in size than those found on cultivated fruit-trees, indicating that they have been better fed during the larva or growing period of their lives." (*Address on Curculio,* 1860, p. 17.) But there is a remarkable fact, which proves satisfactorily to my mind that this cannot be so, and that the two races are perfectly distinct and do not interbreed, each confining itself strictly to its peculiar food-plants. The fact is simply this:—I have beaten hundreds and hundreds of Curculios of the small-sized type off fruiting wild Plum-trees, but I never yet beat a single specimen of the large-sized type, which inhabits Butternuts and Walnuts, off a Plum-tree of any species or in any state. Of course, if that large-sized type had acquired no hereditary indisposition or incapacity to breed in Plums, it would be just as likely to occur on the Plum as on the Butternut or Walnut. But if, as the facts indicate, it really has acquired such a hereditary indisposition or incapacity, and if it interbreeds only with its own race, then—according to what I consider to be the essence of the term "species"—it is a distinct species. You may, if you please, for the sake of precision, give it a distinctive appellation, and call it, for example, a "*Phytophagic* species; but still it is, in my acceptation of the term, a true species.

In the recent much enlarged and improved edition of the "Origin of Species," Mr. Darwin has quoted with general approbation my views upon this very interesting subject, but has incidentally remarked that I am "forced to *assume* that those forms which have lost the capacity for intercrossing should be called species." (*Fourth English edition,* pp. 55—6.) This, I think, can scarcely be called an *assumption.* It is a *definition.* Naturalists have been puzzled for ages to designate satisfactorily what they mean by the term "species," and all kinds of loose and shadowy and intangible explanations of the term have been given; the latest discovery being that of an American refuter of Darwinism, flourishing in the great city of New York, who defines a "species" as a "specific form;" which is much like explaining the term "yellow" by saying that it means "that which possesses yellowness." Darwin himself maintains that species are not essentially different from mere varieties. In their origin, I allow that they are the same; for I believe with Darwin that every species originated from a variety of some pre-existing species. And I further allow that there is a transition period, during which it is impossible to say

whether a particular form is a variety or a species. But that does not prove that varieties and species are essentially undistinguishable. Every man was originally a boy; and there is a certain period during which it is difficult to say whether a particular individual is man or boy; but that does not prove that manhood is undistinguishable from boyhood. For myself, more than a year before I published on the subject of "Phytophagic species," I announced it as my opinion that the meaning of the term "distinct species" was simply "those that do not now in general mix sexually together, or, if geographically separated, would not do so, supposing them to be placed in juxtaposition;" and that "the only valid practical criterion of specific distinctness is the general non-existence, either actually ascertained or analogically inferred, of intermediate grades in the distinctive characters, whence we may reasonably infer that the two supposed species are distinct." (*Proceedings Entomological Society Philadelphia,* 1863, II., p. 220.) It is in this sense, and in this sense only, that I have ever used the term "species;" and to call such a definition an "assumption" seems to me much the same thing as saying that Euclid *assumes* a fact, when he *defines* a circle as a plane figure having all its external points equidistant from a given internal point.

But to return from this tedious digression:—It has long been a puzzle to Naturalists, why the Plum Curculio should cut the well-known crescent-shaped slit in the fruit, and why a round hole would not answer its purpose equally well. Harris and Fitch and other authors tell us, that "it first makes a small, crescent-shaped incision with its snout in the skin of the plum, and then, turning round, inserts an egg in the wound."* Misled by these authorities, and never having personally examined into the point, I copied their statements in my Paper on the Curculio. But Mr. F. C. Hill, of Ohio, has since shown, that we have all of us been in the wrong, and that the Curculio first of all bores a round hole with her snout, "not straight in, but slanting backwards, so that the cavity is just below the skin, then deposits her egg in the hole, and then cuts the usual crescent-slit in front of it, so as to undermine the egg and leave it in a kind of flap, formed by the little piece of the flesh of the fruit which she has undermined." (*Prac. Entomol.* II. p. 115.) Mr. Hill very acutely suggests, that the object of this complicated process is, "to wilt the piece around the egg and prevent the growing fruit from crushing it;"

*See Harris's *Injurious Insects,* p. 76, and Fitch's *Address on the Curculio,* p. 18.

and I have no doubt at all that this is the true explanation of the phenomenon. The same end is attained, as we shall see hereafter, but by a very different process, in the case of the Plum Gouger (*Anthonomus prunicida,* Walsh), an insect belonging to a widely distinct group of Snout-beetles. It may be added here, that the "phytophagic species" of Curculio, that I bred from the green Butternut, makes just the same crescent-cut in the green shuck of that fruit, as does the Plum Curculio in the flesh of the Plum.

In the Paper already referred to I gave my reasons for the belief, that the Curculio passed the winter in the perfect state. Mr. Holcomb, of Cobden, South Illinois, has since assured me, that he also has found the insect under the bark of his trees in the winter. Still, it was difficult to believe, that beetles coming out in the middle of July could live all through the winter, and until the middle of the following June, so as to be able to sting the plums at that period. This difficulty is now, I think, almost entirely done away with. I find that there are two distinct broods of the Plum Curculio every year, the first of which comes out in the beetle state, in the latitude of Rock Island, from about July 19th to August 4th, and the second from about August 23d to September 28th. The first brood of beetles, which is generated by females that have passed the winter in the beetle state, and have attacked the early fruit, lays in the more matured fruit the eggs from which proceed the second brood. The second brood of beetles comes out late in the same season, and the females, at all events, if not the males, live through the winter, and repeat in the succeeding season the process detailed above. Thus, as will be seen at once, the Curculio differs from the Apple-worm or Codling Moth (*Carpocapsa pomonella,* Linnæus), which, as has been already shown, is also double-brooded, in this, that the former passes the winter in the perfect state, and the latter in the larva and pupa states.

After I had made the above discovery, but before I had announced it to any one, Mr. Holcomb, of South Illinois, at a meeting of the American Pomological Society at St. Louis, September 12th, 1867, in opposition to the contrary opinion of Dr. Trimble, the State Entomologist of New Jersey, asserted his belief that in his neighborhood there were two distinct broods of Curculio. And for this belief he gave as a reason, that, in jarring his trees for Curculios, he had observed that there was a particular period in the middle of the summer, during which no Curculios, or, at all events, but very few, were to be met with, while both before and after this period they swarmed. I found, in November, 1867, that many of the other fruit-growers near Cobden, and perhaps all of them, agreed with Mr. Holcomb upon

this matter. I also remark in the *Prairie Farmer* for July 27th, 1867, (p. 55,) the following from Cobden, signed by "V," and evidently written shortly after July 20th, 1867. "There were scarcely any Curculios to be found before the recent rains, since which time they have been coming out of the ground in numbers, and when caught their wing-cases are usually quite fresh and soft—a fact which proves that there are exceptions to the rule that this insect is one-brooded; for, while it may invariably be so in the North, it is more frequently two-brooded in this region."

Still, it must be evident that all these facts are perfectly consistent with my old hypothesis, namely, that the Curculio is only one-brooded, and that those that come out of the ground with soft wing-cases in July, live through the winter and are the same individuals that sting the plums in the June of the following year, shortly after which they die, and a more or less brief interval ensues before the July brood makes its appearance.

Inasmuch as my bare assertion, that there are annually two distinct broods of Curculios, would very probably be disbelieved or disputed by authors, who have hitherto held the contrary doctrine, it may be as well—at the risk of being tedious—to give the details of the experiments upon which my conclusions were based. Those who have no taste for such dry things as facts and figures, can skip the two following paragraphs.

Experiment 1st.—On June 24th, I placed in a large glass vase, with moist sand at the bottom of it, a quantity of wild plums, every one of which I had previously ascertained to bear the crescent symbol of the "little Turk." During the three following weeks I added from day to day a number of plums, all of them bearing the same symbol, that had fallen from a tame plum-tree in my garden. The whole number of plums, as I subsequently ascertained, was 183, and the tame fruit probably formed about a fourth part of the whole. The first Curculio came out July 19th, and with the exception of July 21st and August 1st, there were more or less came out every day till August 4th, inclusive; after which day no more came out. The numbers coming out on each successive day were as follows, the very large number on July 25th having been probably caused by my wetting the sand on that morning rather copiously: 1, 18, 0, 3, 4, 2, 55, 8, 4, 3, 1, 2, 1, 0, 5, 4, 2. Total, 113. On examining the contents of the vase, November 29th, I found five dead and dried-up Curculios among the plums, and among the sand sixteen dead and immature specimens, which had obviously failed to make their way up to the light of day, besides the remains of a good many individuals which

had perished in the sand in the larva or pupa state, and were not counted. The Grand Total from 183 infested plums was, therefore, 134 Curculios in the beetle state, and an unknown number of larvæ and pupæ.

Experiment 2d.—On July 27th, or eight days before the Curculios in the preceding experiment had ceased coming out, I placed in a vase, similar to the above, 243 plums, gathered promiscuously off some badly-infested wild plum-trees. From this lot no Curculios whatever came out till August 23d, and from that day until September 14th more or less came out daily, with the exception of five out of the 23 days, the numbers on the respective days being as follows: 3, 1, 2, 2, 2, 3, 2, 2, 5, 3, 1, 0, 5, 6, 3, 2, 0, 0, 0, 1, 0, 1, 1. Subsequently, on September 18th, there came out 3, on September 24th, 1, and on September 28th, 1; after which no more made their appearance. Total, 50 Curculios from 243 plums, some stung and some not. On examining the contents of this vase on November 29th, I found a single dead Curculio among the plums, making a Grand Total of 51 Curculios bred from these plums. There were no specimens, either in larva, pupa or beetle state, to be found among the sand in the vase on November 29th; which was, perhaps, due to the contents having kept much moister than those of the first vase, though on July 25th I had, as I thought, moistened the sand in the first vase quite sufficiently.

The vases, in both the above two experiments, were examined daily, and the results noted down in my Journal, except during a three-days' absence from home, August 11th—13th, at the end of which time, however, not a single Curculio had come out. Since, therefore, it appears that in large lots of plums, gathered or picked up at various times from June 24th to July 27th, the Curculio ceased coming out for a period of no less than nineteen days, before and after which period it continued to come out for a long while as regularly as we could reasonably anticipate, the inference is unavoidable, that there must have been some cause for the long intermission in its coming out. But I do not see that it is possible to account for this intermission on any other hypothesis, than that of there being two distinct broods. Therefore I infer that there are two distinct broods, the second of which is, of course, generated by the first.

The Curculios, bred from Black-knot in New England, by Prof. Peck, in 1818, are said to have come out July 30th, and a little later (Harris *Inj. Ins.*, p. 79.) Those bred in Canada West, from the same substance, by Mr. Beadle, in 1860, are said to have come out from the beginning of July to August 10th. (Fitch *Address on Curculio,*

p. 25.) According to Dr. Fitch, who lives about 110 miles further north than I do—where, consequently, as also in the two cases just quoted, the seasons would be a little later than with me—most of the Curculios that breed in the plum "leave the fruit and enter the ground in the early part of July, some not leaving for probably two or three weeks afterwards." "They remain," he continues, "in the ground about three weeks. Hence, it is during the latter part of July that the most of them come out in the perfect state." (*Ibid.*, p. 20.) This last writer was evidently not aware, that Curculios may be bred both from Plum and from Black-knot to as late a period as the latter end of September and hence, believing that the species must necessarily be double-brooded, he mistook for young Curculio-larvæ certain minute bodies, that he found in the autumn embedded in a slit in a pear-twig. But these were very probably, I think, not larvæ, at all, but the eggs of some small Leaf-hopper (*Tettigonia* family,) and perhaps those of my Culprit Leaf-hopper (*Chloroneura malefica*, Walsh), which agree precisely with his description, and which I have described as common both on apple-twigs and pear-twigs.* Be this as it may, with no further proof than a general resemblance between the crescent-slit made in plums by the Curculio, and the slit containing minute elongate bodies which he once found in a pear-twig, and without any attempt to breed the perfect insect from these minute bodies, Dr. Fitch has jumped to the astounding conclusion, that the Curculio passes the winter in the larva state inside the twigs of trees.†

Making due allowance for the difference of latitude, it is plain that, in the above-quoted three cases, where Curculios were bred by three different individuals, in New England, in Canada West, and in New York respectively, all that were bred coincided in the time of their appearance with the first brood that I bred at Rock Island, between the 19th of July and the 4th of August, 1867. I myself in 1865 bred seven Curculios from Black-knot, as I have recorded in the *Practical Entomologist* (Vol. I. p. 50,) the first of which came out July 22d and the last September 24th; but unfortunately I have since destroyed the record of the dates at which the remaining five made their appearance, with the exception of an entry on my Journal, that the *second* specimen of the seven came out as late as August 31st, and must therefore, as well as the four following specimens, have belonged to the *second* brood.

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*See my Articles *Prairie Farmer*, Sept. 6, 1862, and April 4, 1863, p. 212, in which last there is given a figure of an apple-twig containing these egg-slits.

†See *Address on Curculio*, pp. 23—4, and *N. Y. Rep.*, II., § 52.

The practical inference to be drawn from the above discovery is this:—I said in my Paper on Curculios that, "by destroying the wormy fruit you do not diminish the crop of Curculios for the current year, but only that for the ensuing year." This was stated on the hypothesis of the species being single-brooded. Now that we know that it is double-brooded, it must be evident that, by destroying in June and early in July, before the larvæ have left the fruit and gone underground, the wormy fruit that produces the first brood of beetles, you prevent that first brood of beetles from puncturing the fruit so as to generate the second brood, and consequently you do "diminish the crop of Curculios for the current year."

It is a mistake to suppose that no plum contains more than one Curculio egg. I counted no less than five plums, that had fallen off my tame Plum-tree, every one of which bore on its surface five Curculio crescents; and in a wild Plum I once (July 28th) counted as many as nine. It must not be imagined, either, that the Curculio ever cuts these crescent-slits by way of food for itself. It does really feed, in the perfect beetle state, on the flesh of the unripe plum, as I ascertained by putting a number of Curculios into a bottle along with some unripe plums that were unwounded by any insect. But, instead of cutting a curved slit for this purpose, it gouges out with its beak a gaping, hemispherical hole, varying in size from that of a radish-seed to that of a small pea. I formerly supposed that it was the Plum-gouger that gouged these holes; but—as will be shown below—that species taps the Plum for food on an entirely different system.

Holes in the plum, very similar to those made for the sake of food by the Curculio, are likewise made by the external-feeding larva of a small brown Butterfly (probably *Thecla falacer,* Bdv. and Lec.,). of which I bred two damaged specimens on June 15th, 1865, from larvæ that fed in this manner on the plum, and had been sent me by Mr. James Ferrel of Muscatine, Iowa, as "quite numerous" on certain plum-trees.

THE LARVA of the Plum Curculio (Fig. 3c), when 0.07 inch long, is 4 or 5 times as long as wide, and of a glassy-white color with a rust-red stomach occupying the middle one-half of its body, and a few pale hairs towards its tail. The head is large and horny, and tinged with yellow, and the mouth is rust-red, with the jaws (mandibles) large and often opening and shutting in a vicious-looking manner, as with many other larvæ belonging to this family.

I do not believe that there is any parasitic insect whatever that preys upon the Curculio. If there had been, so many Curculios as I have bred, I think that I should have met with it. Dr. Fitch, indeed, has figured and described a small *Ichneumon*-fly under the name of

"the Curculio Parasite" (*Sigalphus curculionis*) of which he asserts that "each one of these Flies punctures and destroys probably more than a hundred Curculio worms." (*Addr. Curcul.* p. 26.) But the only proof that he gives of such parasitism is, that he received the Parasites from a Canadian correspondent, who had bred it from Black-knot from which he bred at the same time a certain number of Curculios. Now it so happens that my Plum Moth (*Semasia prunivora,* Walsh,) of which I shall have more to say in Chapter 13th, also breeds in Black-knot as well as in Plums; and it belongs to a group of small Moths, (*Tortricidæ,*) which I know to be infested by *Ichneumon*-flies very closely allied to the so-called "Curculio Parasite." Nay, farther. From the lot of plums gathered July 27th, from which I bred 51 Curculios, I also bred about the same time no less than 13 specimens of this Plum Moth, and, on August 23d, 1 specimen of the identical "Curculio Parasite" described by Dr. Fitch. But from the lot of plums gathered June 24th and subsequently, which produced the very large number of 134 Curculios, besides a number that died in the larva and pupa state, I bred no Plum Moths at all and no Parasites at all. Taking all these facts into consideration, I have every reason to believe, that this so-called "Curculio Parasite" preys upon the Plum Moth, and not upon the Plum Curculio. And if we are to subdue the Curculio by the aid of either Cannibal or Parasitic insects, we must probably look in some other direction than that to which Dr. Fitch has called our attention.

Dr. Trimble, in the first volume of his work on "Fruit Insects," (pp. 77 and 85,) asserts that the Baltimore Oriole or Hanging-bird (*Icterus Baltimorensis,* Linnæus)—an animal very obnoxious to some most intelligent Illinois fruit-growers—preys upon the Curculio. I believe that this is a mistake. Dr. Trimble has an unfortunate crotchet in his head, that every true Plum Curculio has got exactly 147 facets or lenses in each of its compound eyes, never more and never less; and a veritable Curculio which I once sent him he would not allow to be a true Plum Curculio at all, because it happened to have either a greater number or a smaller number—I forget which—of facets to its eyes, than the orthodox number of 147 prescribed in the Gospel according to St. Trimble. To what species it did really belong, he did not undertake to say; but perhaps he would like to grind out of his Scientific Mill a new and hitherto undescribed and unnamed species, for every deficient or additional facet in the eyes of a large lot of veritable Curculios. Be this as it may, his only reason for thinking that this wicked, cherry-stealing, grape-devouring bird, the Baltimore Oriole, does really feed upon the true Plum Curculio is,

that he once found in the craw of one of them the head of some kind or other of Snout-beetle, the eye of which contained exactly 147 facets. Therefore, according to the Doctor's peculiar crotchet, it was a true Plum Curculio. Therefore the Baltimore Oriole habitually eats Curculios. Therefore, we must not kill the Baltimore Oriole, no matter how many grapes and cherries it may steal or spoil. Therefore the Illinois Legislature has done right, in fining every man $5 for every Baltimore Oriole, otherwise called Hanging-bird, that he may be forced to kill, not in self-defense, but in cherry-defense and grape-defense. Which was the thing to be proved.

If closely analyzed, it would be found that a large proportion of the so-called facts, on the strength of which we are commanded to protect all manner of fruit-destroying birds, are based upon foundations as flimsy and as unreliable, as those upon which Dr. Trimble erected his Baltimore castle-in-the-air.

I dilated so fully in the *Practical Entomologist* on the best methods of fighting the Curculio, that nothing remains to be said on that subject.* Volumes might be filled with accounts of the different quack remedies, that have been strongly recommended for this purpose; but the reader will probably be satisfied with the following, with which I shall beg leave to conclude the subject.

CURCULIO AND GAS-TAR. "The remedies for the Curculio the present season are more numerous than usual. There is seldom any of them worthy attention. The last one appears in a Williamsport paper, from a gardener, who says it is a SURE PREVENTIVE. It is this: 'Take a quantity of corn-cobs, with a wire around, terminating in a hook at the end of the cobs; then dip them into gas-tar until they are well saturated. Hang a dozen or more on the tree in different parts, and no Curculio will disturb the tree.' We heard of this remedy 6

*I cannot resist the temptation of quoting here from the *Transactions of the Alton Horticultural Society*, February 7, 1868, some very valuable remarks by Dr. E. S. Hull, on the employment of lime to quell the curculio:

"A few years since, the lime remedy was quite generally received, as a sure protection to the plum. At the time of its appearance in print, we were operating with our Curculio-Catcher, and at once discontinued its use on several of our trees, and made a most thorough trial of the lime, which at first promised to be a success. It did not seem to deter the Curculio from depositing its eggs in the plums, but they did not hatch. Later, the weather becoming dry, the succeeding deposits did hatch, and the larvæ penetrated the plums as freely as in those not limed. Further experiments with the lime proved that, so long as the weather was wet, the lime, or the caustic properties of the lime, was imparted to the water, and entered the perforation in which the eggs were deposited and destroyed them, but was of no value in dry weather."

or 8 years ago, tried it thoroughly, and it had about as much effect upon the Curculio as if the cobs had been dipped in molasses. We mounted one of the trees, and saw the insect at work upon a plum within 3 inches of the tar. We do not believe that a single one was disturbed by it. Not a single plum escaped."—*Germantown (Pa.) Telegraph,* quoted in *Farmers' Advertiser,* Sept. 16, 1867.

CURCULIO AND GAS-TAR.—"I tried, the past season, gas-tar thoroughly, to keep my plums from being stung by the Curculio. I steeped corn-cobs in the tar and hung them all through the trees. It did no good whatever. I often caught the little rascal working over and all around the plums, close to the cobs. They paid it no attention, though you could smell it for rods. A neighbor tried it with utter failure. It is a humbug."—*L. S. F., Rolling Prairie, Wis.,* in *Western Rural,* Dec. 7, 1867.

CURCULIO AND COAL-TAR.—"Having read a statement some time since, that corn-cobs saturated with coal-tar, and suspended from the branches of plum-trees, would keep the little Turk away from the plums, I resolved to try the experiment. I procured a keg of coal-tar and a quantity of cobs, and, after tying a string around each, put them into the tar, and repaired to a favorite plum-tree, prepared to carry the war directly into the enemy's dominions. I first spread sheets under the tree, hammered and shook the rascals out, and gave them the most affectionate treatment. Then, after much tribulation, arising from the fact that the vile stuff would keep dripping from the cobs, and would get upon the strings, reducing my hands and person to much the condition of the cobs, I got them suspended; I mean the cobs, not the hands or the person. I also tied a newspaper loosely around the body of the tree, and smeared it also with tar; then set the keg at the foot of the tree, to heighten as far as possible the effect of the performance, and retired from the field, feeling in several respects as though I *had been and done it.* After some hours I concluded to again visit the scene of operations, and found the whole region suggestive to the olfactories of as vile an odor as it was ever the lot of man to inhale. While noticing the artistic effect of the dripping tar upon the leaves and fruit, I observed a queer-looking gray excrescence upon one of the half-grown plums. A nearer view revealed the appalling fact that it was a CURCULIO 'pegging away' at his favorite pursuit, as much at home in the vile atmosphere around him, as if it were the spicy breezes wafted from 'Araby the Blest.' Need I say that I left the scene in disgust, feeling that coal-tar as a remedy against Curculios was a failure."—*Geo. W. Campbell, Delaware, Ohio,* in *American Journal Horticulture,* August, 1867.

CHAPTER XII.—The Plum Gouger. (*Anthonomus prunicida*, Walsh.)

I have but little to add to what I stated respecting this insect in the *Practical Entomologist;* (Vol. II. pp. 79–80); and I may say likewise, that I have but very little to correct or modify in that article.

These insects take wing quite readily, almost as readily indeed as a Tiger-beetle (*Cicindela*); so that even in my office, where the sun was not shining, on removing some of them out of a bottle, in order to bring a lens to bear on them to watch their operations as they were sitting on a plum, they would generally open their wing-cases almost immediately, and fly off a short distance. In this respect they differ very remarkably from the Plum Curculio, which is a shy flier.

The mode in which the Plum Gouger deposits her egg in the plum, differs radically from that adopted by the Plum Curculio and explained in the preceding chapter. With the minute but powerful jaws placed at the tip of her long and slender snout, the snout itself being held at right angles to the surface on which she stands, she first of all eats through the skin of the plum to a short depth, so as to form a shallow cylindrical hole of precisely the same diameter as her snout, and directed perpendicularly downwards. She then alters from time to time the position of her snout, sloping it first in one direction, and then in another, and then in another still, and all the while working away with her jaws at the flesh of the fruit. By this means she gradually gouges out a gourd-shaped hole, bellying inside and quite small outside, till she has made an opening about four-fifths as deep as her snout is long. The excavated matter is not thrown out of the hole, as is done by a well-digger when he digs a well; but the ingenious workwoman eats her own chips as she works, and thus contrives to gratify her appetite for food, while she is at the same time obeying that wonderful instinct of providing for her future offspring, which Nature has implanted in all female insects without exception. The hole being now sufficiently deep, and sufficiently gouged out internally, the creature withdraws her snout leisurely and gradually, and, pausing for a few seconds, seems to smack her lips at the idea, that she has at one and the same time discharged her duty towards society, and likewise tickled her own liquorish palate. Alas! that we poor human beings can so seldom enjoy that double gratification! And now her maternal feelings tell her that an egg is ready to be born into this world. But she is standing with her snout poised in the air over the excavation, which is intended to receive the egg. The egg-laying apparatus is at the other end of her body. Do you suppose that she is going to drop an egg upon the

smooth, slippery surface of the plum, and then trust to blind chance to dispose of it whether for weal or for woe? No such thing! Insects are not the miserable, thoughtless, careless, improvident machines that most people suppose them to be. They look before they leap. They understand their business. They know as well as the most skillful human mechanic, what would be the consequences of a clumsy movement or an untoward arrangement; and they govern themselves accordingly. Every mother insect has about a hundred, and often several hundreds of eggs to provide for; and although it may, and often does, take weeks or months of the hardest and most unremitting toil, to find or furnish suitable nests or cells or other depositaries for all those eggs, yet, before she dies, her task is almost always accomplished down to the minutest detail. In the Insect World there are no Foundling Hospitals, no Jails, no Penitentiaries. Yet, without hope of reward for well-doing and without fear of punishment for evil-doing, the mother-insects invariably do their duty towards that future progeny, which in the great majority of cases, they are destined never to behold. Do those proud beings, that are foolish enough to fancy that all this beautiful green world—swarming as it is with life and joy upon every inch of its surface—was made for their sole and exclusive benefit, always do the same? Let us blush for our species, when we reflect that the horrible crimes of fœticide and infanticide have prevailed, in every age, to a hideous extent among every nation of mankind; while among my little friends, the Insects, whom we are facetiously pleased to classify among the "lower animals," they are, in the true and correct sense of the terms, utterly unknown. It is undoubtedly the case that the Social Wasps, when at the approach of winter, (with the single exception of the young Queen Wasps, which are destined to pass the winter in a torpid state and to originate new colonies in the following spring,) inevitable starvation stares the whole colony in the face, do, under the stern pressure of necessity, mercifully despatch their young larvæ with their stings, to save them from a painful and lingering death. But how different is this from the conduct of the human mother, who destroys the helpless being that is bone of her bone and flesh of her flesh, not out of any love for that being, but to cover up her own shame from the eye of the world, or even out of the insane ambition of prolonging the period of her youthful charms, or the mere selfish desire to escape from the troubles and responsibilities of motherhood! With a single snap of her jaws the mother Plum Gouger can easily destroy that helpless germ of future life and happiness, which is struggling within her to pass into this outer world. She can do it with perfect impunity.

There are no Courts to convict her of the dreadful deed. She stands in no awe of fine, or imprisonment, or capital punishment. Yet never was such an unnatural act witnessed by the eye of mortal entomologist. With grave and solemn deliberation she turns her body slowly round, deposits the egg as well as may be in the excavation already prepared for it, and finally, turning round once more, re-adjusts it with her snout, till it is completely embedded in its destined receptacle, with its outer surface slightly below the general level of the skin of the plum, and its inner surface overhanging a cavity twice or thrice as large as itself.

"But," the reader may perhaps, ask, "what is the use of this cavity? Why not bore a hole just about the size of the egg, and then at once slip the egg into it?" My friend! the mother Plum Gouger knows better than that! Providence has taught her that the plum, in which she is about to lay her egg, is a growing and living organism, and she has learned as thoroughly as the most experienced human botanist, that any wound that she may produce in it will be speedily healed and filled up by the reparative powers of nature. Providence taught her, too, long before human physiologists discovered this wonderful process of "endosmosis," as it is called, that an egg, full of thick, viscid matter and with a delicate membranous shell, when immersed among the thin sap of the green plum, will necessarily absorb a good deal of that sap, and thus increase considerably in size. She therefore allows full scope and to spare, both for the natural growth of the egg and for the natural growth of the plum. For she is well aware that the slightest pressure will rupture the delicate membrane, within which sleeps the microscopically minute embryo of the future Plum Gouger. And she is well aware, too, that it will be several days, at the least, before the seemingly inanimate egg will disclose the little larva, that will thereafter be abundantly able to fight the rest of his way, with his own good, strong jaws, through this sublunary world.—With all his acquired experience, and all his theoretical knowledge, and all his boasted reasoning powers, could a human workman have provided with more exquisite simplicity for the important object which was to be attained?

Whenever either a male or a female Plum Gouger desires to feed on the flesh of the Plum, they proceed precisely in the same way as the female does, when she excavates in the manner already described a receptacle for an egg. A plum, studded all over with these tiny holes, looks just as if somebody had been puncturing it with a common pin heated red hot. About the latter end of June, I shut up two Plum Gougers, which I had captured at large, in a glass vessel, along with

about a dozen green plums, which I had previously examined and ascertained to be entirely free from punctures or cuts of any kind. In a week's time, these plums were covered with just such punctures as those already spoken of, some exhibiting as many as twenty of them. None of these punctures contained any egg, so far as I could discover; and I repeatedly watched the insects through the glass as they completed one hole, and then immediatly passed on and commenced another, without making any attempt to deposit an egg in the first. Possibly, however, these two Gougers might have been males, or, if females, they might have already exhausted their stock of eggs, or they might have refused to lay eggs except in such plums as were actually growing on the tree. In not a single case, had either of them made the large, open hemispherical excavation peculiar to the Plum Curculio. Holes of the usual character, but bored simply for food, occur also in very large numbers in the plums as they hang on the trees. I have often, in the earlier part of the season, cut into eighteen or twenty of them, before I could find either egg or larva, or the boring-work of a larva; and I have counted as many as nine of them in a single plum, four only of which contained an egg. Later in the season, scarcely one hole out of fifty contains either egg or larva or any signs of a larva. Almost universally from all these holes, for whatever purpose they have been bored, there exudes a copious supply of gum, as is also the case with the crescent-slit of the Plum Curculio.

As I have already shown in the *Practical Entomologist,* the newly-hatched larva of the Plum Gouger, instead of burrowing, like that of the Curculio, solely in the flesh of the plum, makes almost a straight course for the kernel, through the shell of which, being as yet soft, a passage is readily opened by it. Here it remains, feeding exclusively upon the kernel, till it has acquired its full larval growth, when it cuts the same smooth, round hole through the now quite hard shell of the plum-stone that almost all boring-larvæ make, in order to afford a ready exit for the perfect insect. It then changes into the pupa state inside the plum-stone; the plum itself not dropping in a green state from the tree, as is almost invariably the case with plums stung by the Curculio, but hanging on the tree and ripening prematurely. Subsequently, the pupa develops into the perfect Plum Gouger, and the latter emerges through the hole already prepared for it by the provident care of the larva.

I suspect that I have rather over-estimated the destructive powers of the Gouger, as compared with those of the Curculio. The punctures, indeed, of the former are enormously abundant, out-numbering, certainly, fourfold the crescent-slits and the gouging-work of the

latter; but only a very small percentage of these seem to contain eggs. No doubt such punctures greatly injure and disfigure the fruit, and the gum that exudes from them exhausts, to no purpose, the vital energies of the tree. Still, a plum that is simply punctured, without any egg being deposited in it, is not totally destroyed; for the wound is but temporary, and nature can generally repair the damage. But whenever an egg is inserted in the wounded part, then, unless that egg fails to hatch out, or the young larva dies of disease, the unhappy plum is doomed; for soon the resistless energies of the larva are, day after day, eating into its vitals. It is immaterial whether the larva, after hatching out, burrows exclusively in the flesh of the plum, as in the case of the Curculio; or whether, passing through the flesh as rapidly as possible, it strikes a bee-line for the kernel, as in the case of the Gouger. In either case, the fate of that plum is premature death; the only difference being, that the plum stung by the Curculio perishes in its infancy, while that which is stung by the Gouger attains a sickly and stunted manhood before it finally perishes.

In illustration of the wide difference between the respective habits of the Curculio and the Gouger, I will give a few statistics: 1st. On June 24th I placed 165 wild plums, all of them more or less copiously punctured by the Gouger, and none of them, so far as I could perceive, with any crescent-slits, in a similar glass vase to those already described in preceding experiments. (Above, pp. 90—1.) From this vase, which was treated in the same manner as the others, I expected to have bred several Gougers. I did not breed a solitary one; and all the insects that I obtained from this whole lot of plums, were two Curculios that came out, respectively, July 30th and August 1st. Neither, on examining the sand at the bottom of the vase on November 29th, could I discover the remains of either larva, pupa or perfect insect, that had perished there prematurely. As two veritable Plum Curculios were bred from this lot of 165 plums, I presume that there must have been at least two crescent-slits on them, which I inadvertently overlooked. 2d. From the vase of wild plums, gathered July 27th, the details of which have been already given, (above, p. 91), I bred, as I showed before, no less than 51 Curculios; and yet, from this same lot—which, be it remembered, was gathered off the tree promiscuously and without any selection—I obtained only two Gougers, which came out, respectively, August 24th and 26th. The reason of all this is pretty plain. A plum inhabited by the Gouger larva would naturally hang on the tree, so that the kernel would become fully developed; and by plucking all these plums more or less prematurely from the tree, I caused the premature death of a

great many Gouger larvæ. On the other hand, a plum inhabited by the Curculio larva naturally falls from the tree, and thus my arrangements, so far as regards this species, interfered in no wise with the laws of nature.

THE LARVA of the Plum Gouger, when found burrowing in the kernel on July 20th, by which time the shell of the kernel was quite hard, was 0.12 inch long when partially straightened out, and 0.10 inch long when curled up in the usual semicircular form. The color was milk-white, not whitish-glassy as in the Curculio larva, and there was no rust-red stomach as in the Curculio larva. The head was large, horny, and of a yellowish-white color, the jaws (mandibles) being tipped with brown. The plum in which this larva occurred had only been gathered four or five days previously. Another larva, that had already bored into the kernel and was met with July 28th, in a plum gathered the day before, differed only in the head not being tinged with yellow, and in the jaws being almost entirely brown.

Whether there be one or two broods of this insect every year, I cannot say with certainty, but I strongly suspect that there is but one. The perfect beetles appear on the plums early in June and deposit their eggs therein, precisely as does the Curculio at that date, though, as has been shown, on an entirely different system. According to Mr. L. C. Francis, of Springfield, Central Illinois, (who is a very successful plum-grower and follows the plan of jarring his trees regularly during the summer,) after June 7th, although he had previously found "about equal numbers of the Gouger and Curculio," the Gougers entirely disappeared, Curculios being still met with up to the last of July. (*Prairie Farmer,* March 19, 1864.) This certainly seems to indicate, that there is no such early brood of Gougers coming out in July as there is of Curculios. From a large lot of plums that I gathered myself off the tree June 24th, and that must have contained many of the eggs of the Gouger—for I found several eggs in the few that I cut open—I failed, as already said, to breed a single Gouger; but I attribute this to the fact, that these plums would naturally have hung on the tree till the kernel would have been more fully developed. On July 20th and 28th, as I stated just now, I found in plums but recently gathered larvæ that could not have been much more than half-grown; so that the probability is, that the plum infested by this larva must naturally hang on the tree till the kernel is nearly perfected—that this larva requires a much longer time to mature than that of the Curculio—and that eggs deposited early in June do not develop into the beetle state till the end of August or perhaps the early part of September. The two Gougers actually bred by me this year came out, as will be recollected, August 24th and 26th. And there is nothing at all improbable or anomalous in a

Snout-beetle, which comes out so late in the year, living all through the winter and until the following spring. At any rate, as all the other species of the genus (*Anthonomus*), whose transformations are known to me, are only single-brooded, the presumption is that this species is the same; and if any one holds the contrary opinion, the burden of proof rests upon his shoulders.

Whether the Plum Gouger is confined to the Valley of the Mississippi, or whether it occurs also in the Atlantic States, is not quite clear. None of my Eastern correspondents have met with it at the East, and neither Fitch nor Harris describe the species. Indeed, common as it is with us upon Plums, it was unknown to Science, until I described it in 1863 in the *Prairie Farmer,* with a brief account of its habits, which description was subsequently reproduced in the *Proceedings of the Boston Society of Natural History.* (IX., p. 309.) From some observations, however, let fall by Dr. Fitch, I infer that fruit is infested in New York either by this or by some allied species; for in the *Address* which has been already so often quoted, (p. 18,) he says that "in addition to the crescent-shaped slit, the Curculio wounds the fruit by drilling holes therein with its beak, resembling punctures made by a coarse pin or needle;" and he adds that "one or more of these punctures may be seen upon almost every fruit which it invades," and that "it is probably for feeding upon the juicy pulp of the fruit that the insect bores these small holes in it." Now, as already stated, I have had 8 or 10 Curculios shut up in a glass vessel for a month, along with a lot of plums that I had previously ascertained to be free from punctures or wounds of any kind. These Curculios fed freely upon the flesh of the plums. But all their excavations were of the open, hemispherical type already described, and there was not a single puncture to be met with, such as the Gouger makes and such as Dr. Fitch asserts to be made by Curculios. I cannot think it at all probable, therefore, that the Curculio, as Dr. Fitch asserts, commonly causes such punctures. Possibly, as this writer appears to be speaking here with more especial reference to the apple, the punctures he mentions may have been made by the Four-humped Curculio (*Anthonomus quadrigibbus,* Say,) which species I was the first to publish as infesting the apple in this manner in Illinois, and which causes nearly the same kind of puncture in the Apple, as the Gouger causes in the Plum. But neither has this species been enumerated as among those, that are injurious to cultivated fruit in the East, either by Dr. Harris or by Dr. Fitch, though I presume that it occurs there, as Say asserts that it is found generally in the United States.

Such are some of the many difficulties which the Student of Economic Entomology encounters, owing to the custom, too prevalent among closet-naturalists, of despising the habits of animal as unworthy of their notice, and devoting their exclusive attention to its coloration, its structure, and its classification. "And yet," as Agassiz has so truthfully remarked, "without a thorough knowledge of the habits of animals, it will never be possible to ascertain with any degree of precision the true limits of all those species, which descriptive zoologists have of late admitted with so much confidence in their works. And, after all, what does it matter to Science, that thousands of species, more or less, should be described and entered in our systems, IF WE KNOW NOTHING ABOUT THEM?" (*Contributions*, etc., I. p. 57.)

Since, as has been shown above, plums infested by the Gouger do not fall prematurely from the tree like those which are infested by the Curculio, it is plain that picking up and destroying the fallen fruit, though an excellent mode of counterworking the latter insect, will be of no avail against the former. Both species, however, can be jarred off the trees and destroyed; and when this process is performed, a sharp look-out should be kept for both. It will also be a useful precaution, whenever a few stunted plums are observed to ripen prematurely on any tree, to pluck them off and destroy them. In most cases, they will be found to contain, either the perfect Gouger, or the larva that is destined subsequently to develop into the Gouger, snugly ensconced in the kernel, and often with the hole already bored through the stone for the escape of the matured insect.

The wide differences between the Curculio and the Gouger may be thus briefly stated:—The Curculio is beautifully streaked and spotted with black and white and has two shining black humps, like black sealing-wax, on its back; the Gouger is clay yellow in front and of a dull lead-color behind, without any humps at all. The Curculio cuts a crescent slit in every fruit in which it lays an egg; the Gouger bores a small round hole for this purpose. The Curculio larva bores exclusively in the flesh of the fruit; the Gouger larva always strikes a bee-line for the kernel. The Curculio larva leaves the fruit and goes underground to pass into the beetle state; the Gouger larva remains throughout in the infested fruit. Of the Curculio there are two broods every year; of the Gouger there is apparently but a single brood. Finally, every stone-fruit except Cherry that is stung by the Curculio falls, as a general rule, prematurely to the ground; while the plums stung by the Gouger hang on the tree and ripen prematurely.

CHAPTER XIII.—The Plum Moth. (*Semasia prunivora*, Walsh.) Fig. 3.

On July 28, 1867, I was cutting into a number of plums infested by the Plum Curculio and the Plum Gouger, when to my great surprise I discovered in one of them what was evidently the larva (fig. 3b) of some small moth. On comparing this figure with that of the larva of the Plum Curculio (fig. 3c)—which scarcely differs in outline from that of the Plum Gouger—the difference will be seen at a single glance. The plum in which it occurred bore the crescent slit of the Curculio; but what had been the history of the egg deposited by the mother Curculio—whether it had failed to hatch out—or whether it had hatched out and shortly afterwards perished—or whether it had hatched out and reached maturity in the plum, and then gone underground—I did not ascertain. In the year 1868 I hope to clear up all such points as these; upon which depend a variety of interesting questions in the history of the moth-larva that accompanied the egg-slit of the Curculio.

About a month afterwards, from a lot of infested plums gathered July 27th, the details of which have been given above (p. 91,) there commenced coming out the small moth figured and described herewith as the Plum Moth (fig. 3;) and specimens continued to come out from time to time until the middle of September, amounting in all to 13. Evidently all these moths must have proceeded from larvæ, such as that which I had found in the plum at the end of July.

In the preceding year, and at the same period of the year, from the well-known Black-knot—a fungoid excrescence on the branches and twigs of the Plum-tree, which is infested by the larvæ of the Curculio to nearly as great an extent as the Plum itself—I bred several specimens of this same moth; and in this same Black-knot I had previously met with many of its larvæ burrowing in the substance of the Black-knot. I bred two other specimens of the same moth nearly a month earlier in the season from a cockscomb-like hollow gall (*ulmicola,* Fitch) on the leaf of an elm, which is produced and inhabited by Plant-lice, having previously found its larva inside the gall and among the Plant-lice. And lastly, I had bred on September 2d, 1866, a single specimen of this very same moth from a sessile, hollow gall about the size and shape of a large pea or a small cherry, on the leaf of the Red Oak (*Quercus rubra,*) which has been named and described by Mr. Bassett, (*Quercus singularis,* Bassett.*)

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*I formerly supposed that this gall was the *nubilipennis* of Harris. It is clearly the *nubilipennis* of Fitch. But I rather believe that the *Quercus-sculpta* of Bassett—a fleshy, juicy, subacid, grape-like, eatable gall growing indifferently on the Black Oak (*Quercus tinctoria*) and the Red Oak—is the

In both these two cases, the galls were of the same year's growth, and inhabited by the gall-making larvæ at or shortly before the time that the Moth made its appearance. Thus we see that the very same moth inhabits in the larva state plums that are infested by Curculio, Black-knot that is infested by Curculio, an Elm-gall that is generated and inhabited by Plant-lice, and an Oak-gall that is generated and inhabited by a Gall-fly.*

In the two latter cases my Plum Moth is clearly a Guest-moth; but whether it confines itself to feeding on the substance of the gall, or whether it also destroys the gall-makers, and whether, if it destroys them, it feeds on them, and, in the case of the Plant-louse gall, whether it may not feed partly on the sugary dust secreted from the body of the insect, are all of them points that remain to be investigated and explained. Most authors state that the larvæ of this entire Order (*Lepidoptera*) are almost exclusively vegetable-feeders;† and some have even gone so far as to say, that they feed entirely on vege-

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one that Harris had in view, when he spoke of his *nubilipennis*. For the *mature* female fly produced from *Quercus-sculpta* has a very distinct dark cloud on the terminal ½ of its front wing, as Harris describes his gall-fly (*Cynips nubilipennis*); while both the male and the female Gall-fly of the other Oak-gall (*Q. singularis*) have no such cloud. *Immature* specimens, indeed, of the female *Cynips q. sculpta*, cut out of the gall, do not show this cloud; and it was probably from such that Mr. Bassett drew up his description, which says nothing of any such cloud. The *male* fly of *Cynips q. sculpta* I have never yet met with. In any case, Harris's description (of his *nubilipennis*) is so brief and indefinite, that not being sufficient to identify either the gall or the insect satisfactorily, it should be entirely neglected and thrown on one side, and we should adopt Mr. Bassett's two names. To follow any other rule in such cases as these, is simply holding out a premium to slipslop, slovenly describers, who are the curse of Science.—See Osten-Sacken in *Proc. Ent. Soc. Phil.* IV. pp. 355—6.

*Similarly, I have bred the small moth *Gelechia gallægenitella*, Clemens, from a Willow-gall made by a Gall-gnat, and likewise from two distinct kinds of Oak-galls made by Gall-flies. Also *Batrachedra salicipomonella*, Clemens, another small moth, from a Willow-gall made by a Gall-gnat, and from two very distinct Willow-galls made by two distinct species of saw-flies. (See *Proc. Ent. Soc. Phil* VI. p. 273.) I may add here the hitherto unpublished facts that I bred on June 26th from the Oak-gall *Quercus inanis* O. S., which is made by a Gall-fly (*Cynips*), the *Anorthosia punctipennella* of Clemens; and three other distinct species of small moths, respectively, from three other distinct Oak-galls, two of which are made by Gall-flies and one by a Gall-gnat (*Cecidomyia*). In all these cases, and in many others which I have published, the moths are clearly guests in galls made by other insects.

†Westwood *Introd.* II. p. 331; Harris *Injur. Insects* p. 258; &c, &c.

table food.* But, as Harris has well observed in the passage referred to in the note, there are certain species that feed in the larva state on our woollens and furs, and even on leather, meat and lard—all five of which are, not vegetable, but animal substances; and it is well known that certain other species infest in the larva state collections of dried insects. Moreover, I have long been inclined to suspect, that the larvæ of particular moths feed habitually, not only on dead animal substances, as in the instances quoted above, but even on the living bodies of other insects. The Rev. Mr. Green, of England, in his admirable little work on Pupa-digging, has stated some facts, which certainly seem to prove that there are Cannibal Caterpillars, as well as Cannibal Beetles and Cannibal Flies. For he says that the larvæ of a small moth had swarmed for years in his breeding-cages, in spite of all that he could do, devouring by wholesale the pupæ, from which he was endeavoring to rear various kinds of moths.†

If, therefore, we allow that this Plum Moth of mine is a Guest in the case of the two galls, which, as I have shown, it inhabits, it would seem to be most probable that it is also a Guest whenever it inhabits the Black-knot and the Plum. In other words, it does not attack sound Black-knot and sound Plums, but only such as have been already preyed on and bored by the Curculio, and where consequently an opening has already been made for its operations. Practically, this question is of considerable importance. For, if the Plum Moth does really attack perfectly sound plums, then it is as much to be dreaded as the Curculio. If, on the contrary, it only gathers up the crumbs that fall from the table of the Curculio, then it is absolutely harmless. For no fruit-grower would give one cent for a whole orchard of plums, every one of which was stung by the Curculio. The general subject of Guest-flies and Guest-moths, has been already treated of at some considerable length. (Above, pp. 19—20.

I have bred another species of small moth, very closely allied to the Plum Moth, from Black-knot; and Harris long ago noticed Lepi-

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*Latreille *Gen. Crustac. Insect.* IV. p. 185; Wallace *Malayan Papilion.* in *Transact. Linn. Soc.* XXV. p. 2.

†Since the above was written I have received the following valuable information from H. T. Stainton, the distinguished English Lepidopterist: "You are quite right in saying that several lepidopterous larvæ are carnivorous. Amongst the *Noctuæ, Scopelesoma satellitia* and *Cosmia trapezina*, and amongst the *Geometridæ, Crocallis elinguaria* are larvæ to be carefully avoided by those intent on rearing other larvæ. The larva of *Œcophora pseudospretella* is the mortal foe to the choice pupæ of the collector, and *Diplodonia marginepunctella* is evidently addicted to carnivorous appetites, and adorns his case with the mutilated bodies of his victims."

dopterous larvæ in Black-knot, which he originally mistook for those of the Peach Borer (*Ægeria exitiosa*, Say;) though he subsequently corrected this error, and stated them to be "the naked caterpillars of a minute moth."* In all probability, these caterpillars, which Harris found in Black-knot, would have produced some one or both of the two species of Moths which I have bred therefrom, namely, the Plum Moth and an undescribed species. Although these larvæ had long been noticed by entomologists in Black-knot, yet nobody, as it seems, had ever raised them to the mature state, until I succeeded in doing so.

As I have already shown (p. 93--4,) the so-called "Curculio Parasite" of Dr. Fitch preys, in all probability, not upon the larva of the Curculio, as Dr. Fitch erroneously supposed, but upon that of the Plum Moth. I bred a single female specimen of this pretty little *Ichneumon*-fly on the 23d of August, from the same vase of plums from which I bred all my Plum Moths.

THE PLUM MOTH; Fig. 3. (*Semasia prunivora*, new species.) Ground-color of *front-wing*, black. The basal 1/4 irregularly covered with rust red, so as to leave only a few black markings. On the costa and rather more than 1/3 of the way to the apex of the wing, a pair of streaks obliquely directed toward the posterior angle of the wing;† the inner streak of the pair is on its extreme costal end clear white, elsewhere pale steel-blue, and extends nearly to the disk of the wing, where it almost unites with a sub-quadrangular pale steel-blue blotch, which is usually seen there without difficulty, though it is occasionally subobsolete; the outer streak of the pair is only half as long as the inner one, towards which it converges very slightly without actually uniting with it, and is colored in the same manner. Further along on the costa, and not quite 2/3 of the way to the apex of the wing, there is another such pair of streaks, parallel with the first pair and similarly colored, the inner one of which, when it has become as long as the inner one of the other pair, sweeps in a gradual curve round the disk of the wing, till it almost attains the inner margin a little way from its tip; while the outer streak of the two is so very short, that the steel-blue part of it is subobsolete and can only be seen in certain lights. Beyond this second pair of streaks, and rather more than 3/4 of the way along the costa to the apex of the wing, is another streak, parallel with all the others and similarly colored, which strikes the outer margin about 1/3 of the way from the apical to the posterior angle, where it terminates in a pale streak in the fringe.

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* Compare Harris's *Injur. Insects* first edition, p. 352, and last edition, p. 80. A writer in the *Amer. Journ. Horticulture* (Vol. II. p. 34) has reiterated Harris's original error.

† In the figure this pair of streaks is erroneously engraved as being rather closer to the second pair of streaks, and rather further apart from each other, than is the case in the natural wing. And the same observation applies to the second pair of streaks as regards its distance from the third group of streaks which consists, not of 2, but of 3.

And beyond this again, and equidistant from it, from each other, and from the apex of the wing, there is on the costa a pair of short white streaks, the inner one much the shorter of the two. Thus along the costa we have a series of seven very conspicuous short white streaks, arranged 2, 2 and 3. The terminal ¼ of the front wing is mostly rust-red, with a series of abbreviated, black, longitudinal lines, springing from the outer edge of the curved prolongation of the inner one of the 2d pair of streaks on the costa; and beyond these short black lines are two very oblique, short, pale steel-blue streaks, one springing from the posterior angle and the other a little above it from the outer margin. Disk of the front wing rust-red, with many indistinct, short, black, longitudinal lines, and on its centre the pale steel-blue blotch already referred to. On the middle of the inner margin, a large, elongate-triangular, rust-red patch, the apex of the triangle directed towards the apex of the wing and attaining the disk, the base of the triangle occupying nearly ¼ of the inner margin. This triangular patch is bisected lengthways by a very elongate and slender black triangle, the apex of which attains its apex; and the rust-red space on each side of this last triangle is again indistinctly bisected lengthways by a still more elongate triangle composed of confluent black atoms. Fringe dusky, with a black basal line all along it. *Hind wing* dusky-gray at base, shading into black at tip. On the middle of the outer margin, *in the male but not in the female*, an elongate semi-oval patch (fig. 3a) of metallic-brassy scales, brighter in certain lights. *Fringe of the male* (fig. 3a) long, sparse and grayish-white on its anal ½, short, dense and dusky with a basal black line for its remaining ½. *Fringe of the female* (fig. 3) nearly of uniform length, coarse and dusky throughout on the ½ next the wing, then suddenly fine and grayish-white on its outer ½. *Body* brown black. *Face* and *palpi* grayish-white. *Shoulder-covers* largely tipped with dull rust-red. Tips of the abdominal joints pale fuscous above. *Legs* dusky. All beneath, including the legs, with a more or less obvious silvery-white reflection.

Described from 13 specimens, (4 males, 9 females) bred from infested plums August 23d—September 15th. The males were readily distinguished by the exserted anal forceps. Three specimens bred from Black-knot, Aug. 31—Sept. 7th, three others bred from the Elm-Gall (*Ulmicola*, Fitch) July 26th—Aug. 5th, and a single one bred from the Oak-Gall (*Q. singularis*, Bassett) on Sept. 2d, none of them differed from the plum-fed specimens in any important point. I sent a single specimen, bred from the Black-knot, to the late Dr. B. Clemens, about a year before his lamented death; but he never, so far as I know, investigated its classification. For the satisfaction of the incredulous, I may add that I sent specimens, bred respectively from the Plum and the Elm-gall, to the distinguished English Entomologist, H. T. Stainton, who is well known to have made the smaller moths his special study for years; and that he agrees with me that they are "perfectly identical." It is to the kindness of this gentleman that I am indebted for the generic determination of this species, and for the following very valuable comparison of it with the European species (*S. janthinana*) which, as he informs me, is the most closely allied to it. The small European moth (*Opadia funebrana*, Treitschke), which I quoted in the *Practical Entomologist* (II. p. 79) as occasionally boring into plums in England, has been referred, as Mr. Stainton informs me, both by himself and by Wilkinson to the same genus to which

the Codling-moth (*Carpocapsa pomonella*, Linnæus) belongs; and is consequently widely distinct from my Plum moth. Mr. Stainton further tells me that, just as I anticipated in the *Practical Entomologist*, "in some years this insect is injurious to the Plum-crop in England, but the moth is entomologically scarce, and few collections are well supplied with it." "I have not," he adds, "obtained a single specimen for more than 20 years."

"*Semasia prunivora* is allied to *S. janthinana*, Duponchel—which, if I remember rightly, has been bred from gall-like growths on hawthorn twigs, though V. Hernemann, who gives no habitat for the larva, says that the imago frequents sloe-bushes [the English wild plum]—but with the anterior wings narrower, the pale mark from the middle of the inner margin more obliquely placed, and with four distinct transverse leaden-blue streaks from the costa. In *Janthinana* there are no leaden-blue streaks. In the centre of the pale dorsal [discal?] blotch is a distinct darker line, rather more defined than in *Janthinana*. On the surface of the anterior wings are numerous short longitudinal pale orange streaks, which give the insect a much brighter appearance than we see in *Janthinana*. Lastly, the posterior wings are, towards the hind margin, blackish, and therefore much darker than in *Janthinana*."

THE LARVA, when 0.11 inch long, is about 6 times as long as wide, of a dingy white color, with some fine short dusky hairs. Head, a horny obsemicircular plate on the 1st segment behind the head, and a horny semicircular plate on the anal segment, all black and polished. Legs and prolegs, dingy white. When 0.18 inch long, the body is of a pale brownish yellow color, and the two horny plates on the body are brown, not black, but the head remains black.

Described from one specimen found in a plum July 28th, and one (of the larger size) found in Black-knot July 22d. The former was wounded; the latter I isolated in a separate bottle, and subsequently bred the moth from it.

THE COCOON spun by the larva is formed above ground, among the plums from which the full-fed larvæ have made their exit, or is sometimes attached to neighboring substances. It is composed of dark-colored silk arranged in the usual elongate-oval form.

THE PUPA I have not seen.

Mr. C V. Riley informs me, that according to H. N. Humphreys, (*Genera of British Moths,*) the larva of a European species is the same genus to which the Plum Moth belongs (*Semasia wœberana,*) is supposed to feed on the inner tegument of the bark of plum-trees, cherry-trees, apple-trees and occasionally laurels. This is only another illustration of the law of "Phytophagic Unity," as I have called it, which has long been known to prevail to a considerable extent among the larvæ of the Butterflies and the Moths, namely, that the same group of Insects affects the same group of Plants.* I have shown that this law also holds good among almost all the groups of

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*See Westwood *Introd.* II. pp. 321—2, etc., etc.

gall-making insects, the gall-makers belonging to the Order of Two-winged Flies (*Diptera*) forming about the only exception.*

Of course it would be premature to talk of any remedy against the depredations of this elegant little jewel of a moth, until we know for certain whether as I suppose she is a Guest in the Plum, and consequently a neutral; or whether she burrows into the Plum on her own account, and is therefore to be treated as an enemy. I hope that —as will sometimes happen both with Eastern and with Western juries—the beauty of the fair defendant has not warped my judgment, and induced me to bring in a verdict of "Not guilty," when, in reality, she richly deserved to be sent to the Penitentiary.

INSECTS INFESTING GARDEN-CROPS GENERALLY.

CHAPTER XIV.—The Hateful Grasshopper, (*Caloptenus spretus*, Walsh.)

This insect, as will be seen hereafter, is about seven times as destructive to garden crops, as it is to field crops; and it, therefore, falls legitimately within the purview of this Report. It has never yet, so far as is known, invaded this State; and I do not believe that it ever will or can. Still, as many of our farmers and gardeners in Illinois have an idea, that it may not improbably, at some future time, pass from Missouri and Iowa into Illinois—just as the notorious Colorado Potato-bug (*Doryphora 10-lineata*, Say) has done—it may be worth while to investigate its Natural History, and to demonstrate the improbability of its ever crossing the Mississippi in the course of its Eastward progress. It is the province of Economic Entomology, not only to forewarn the Agriculturist of the approaching insect foe, but also to dissipate any groundless fears of such a foe that may prevail, when it can be proved that such fears are really groundless.

In the *Practical Entomologist* for October, 1866, (II., pp. 1—5,) I investigated the migration of this Hateful Grasshopper, from the canons (kanyons) of the Rocky Mountains, into the lowlands of Kansas, Nebraska and Western Missouri, which had just then taken place. I further stated my belief that the eggs, which had been that autumn deposited by the females in the ground throughout the infested region in countless myriads, would not generally hatch out that autumn and be destroyed by the frosts—as many fondly anticipated—but that the great bulk of them would lie safely in the ground through the winter, and hatch out as the spring of 1867 opened; when, in all likelihood,

*See my Papers *Proc. Ent. Soc. Phil.*, I. pp. 461—2; III., p. 635; VI., p. 277.

the larvæ that proceeded from them would do a vast amount of damage to the young crops. But, at the same time, I distinctly foretold, that the grasshoppers developed from these eggs, in 1867, although their general health would, perhaps, not be materially injured, would yet have their generative systems so impaired by the difference in food-plants, climate, density of the air, temperature, moisture, etc., (or what Naturalists call the "Conditions of Life,") which they met with in the lowland country, that they would become incapable of propagating their species any further; and consequently that that entire brood of grasshoppers would "then and there die out." Whence I deduced the corollary, that they could never cross the Mississippi and gradually spread eastward, as the Colorado Potato-bug has notoriously done, and as I prophesied before-hand that it would do. (See my Paper on that insect in the *Practical Entomologist* for October, 1865.)

Now let us see how far the facts have verified my predictions; and if it appear that I have been a true prophet, both in the case of the Colorado Potato-bug and of the Hateful Grasshopper, then I have a right to ask that, for the future, some little more attention should be paid to my opinions on such subjects, than to the wild fancies of men, who know no more about insects and their habits and peculiarities than a newly-born baby does of the multiplication-table. But first, let us examine a few additional details as to the operations of the Hateful Grasshopper in the autumn of 1866, in Texas and in Missouri, through which States I had not previously mapped out its course.

The Hateful Grasshopper in Texas in 1866.

"*Collins Co., North-east Texas, Oct.,* 1866.—Grasshoppers appeared in the north-west part of this county about September 1st, and destroyed all the wheat that had come up, and then passed on to the south-west. They have nearly disappeared. They fly very high, and in some places were so thick, that we estimated them at one to the square inch."—*Monthly Report Agricultural Department,* 1866, p. 441.

The Hateful Grasshopper in Missouri in 1866.

"*Leavenworth, North-east Kansas,* Oct. 18, 1866.—Our *eastern* mail a few days ago was late, because the train was stopped by Grasshoppers. The track became so slippery by the crushing of their bodies, that the wheels would not turn."—*Private letter from C. H. Cushing.*

"*Atchison, North-east Kansas,* Feb., 1867.—In September, 1866, the Grasshoppers spread over the whole of Kansas, and before cold weather they advanced about 50 miles into Missouri. They devoured

all our buckwheat, turnips, tobacco and most of the green fodder, and all the young wheat that had been sown."—*L. A. Alderson, in the American Agriculturist, March,* 1867.

"*Jackson Co., Missouri, March,* 1867.—The Grasshoppers did not make their appearance in this county until about the 1st of October, which was too late for them to do the amount of injury here that was done further west. Fall wheat, young timothy, and other kinds of tender grass were completely eaten off, and their eggs deposited in multiplied millions."—"B.," in *Country Gentleman, March* 28, 1867.

"*Cass Co., Missouri, October* 21, 1866.—We are overrun with Grasshoppers, which apparently came here from Kansas. They are destroying everything that remains green. They have completely swept off our newly-sown wheat. They destroy all remaining vegetables, such as cabbage, turnips, etc. They even stopped our neighbor across Grand River from boiling molasses; for the old gentleman said that they would persist all the time in jumping into his pan. They made their first appearance about October 8th or 10th. After they had been here some days, they commenced coupling and depositing their eggs in the ground. The eggs are encased in a small bag composed of some gummy substance."—*Private letter from J. M. App.*

"*Savanna, Andrew Co., Missouri, December,* 1866.—The people of this county are greatly troubled to know, what the big lot of Grasshoppers will do next year. They did not do *very* much harm this year, though their name was legion and they darkened the sky in their passage."—*Private letter from A. Kennicott, kindly communicated by Dr. W. Stimpson, of the Chicago Academy of Science.*

"*Clinton Co., Mo., November,* 1866.—Grasshoppers have eaten down into the ground every blade of green wheat that was sown this autumn, so far as they have extended over the country. They came from the west and are moving east as fast as they can, eating up all vegetation. They are as numerous as chinch-bugs ever were in Illinois, laying the ground full of eggs as they go. Cold nights seem to affect them but little. They rise and fly the same as a bird, and take very long flights."—*"B. S.," in Prairie Farmer, November* 24, 1866.

"*Stewartsville, Clinton Co., Missouri, November* 15, 1866.—The Grasshoppers have completely overrun north-western Missouri this autumn. They began to cross the Missouri River in September, coming from Kansas and the far West. They came too late for this year's crops, save the autumn-sown wheat and rye, which have been entirely swept away by them, except in some partial spots. They seem to be

pressing on due East, depositing their eggs in the ground and literally filling the whole surface of the earth with them."—*Private letter from A. Kilgore, obligingly sent to me by Mr. S. S. Rathvon, of Pennsylvania.*

With the exception of Jackson and Cass counties, which lie on the middle of the extreme western border of Missouri, all the other districts referred to above lie in the north-west corner of the State. St. Joseph, Buchanan county, which will be subsequently referred to as a point where grasshopper-eggs hatched out in the spring of 1867, also lies in the north-west corner of the State. Kansas City and Oregon, which are referred to in the same series of extracts, lie respectively in Jackson Co. and Andrew Co. The whole of these districts, therefore, are separated, by a very wide interval, from Illinois.

WHAT THE HATEFUL GRASSHOPPER DID, WHEN IT HATCHED OUT, IN THE SPRING OF 1867, IN THE LOWLANDS OF THE MISSISSIPPI VALLEY.

I have inserted here all the *facts* that I could find bearing upon the above subject, omitting, for the most part, what is evidently *mere speculation and opinion.* Some few of the following reports are plainly colored by the same local feeling, that prompts almost every Western man to deny that there is any fever and ague, or any mosquitoes of any consequence, in his own settlement; although "in such a place," as he will invariably tell you, "the people are shaking the teeth out of their heads; and as to the mosquitoes there, they will absolutely eat a fellow up alive." So far as possible, I have reduced these extracts to their proper chronological order.

"*Texas, about May* 6, 1867.—A cold snap has killed off all the grasshoppers that threatened to overrun Texas."—*N. Y. Sem. Tribune, May* 14, 1867.

"*Padonia, Kansas, May* 13, 1867.—Farmers are through sowing their wheat, but, to judge from the look of things, the Grasshoppers will harvest it for us. They are hatching daily, and cabbage, lettuce and onions are being devoured by them."—"*J. F.*" *in Prairie Farmer, May* 25, 1867.

"*Nebraska, May* 14, 1867.—Wheat, oats, etc., are coming up and are looking quite fresh and green, but the Grasshoppers hatched out from the eggs deposited last autumn have already commenced feasting on the green grain."—*S. C. Maxima, in Rock Island* (*Ill.*) *Union.*

"*Omaha, Nebraska, May* 18, 1867.—The eggs of the Grasshoppers are now hatching by the million. They are deposited over the whole face of the country, from the lower part of Cass county, clear

through to the southern part of Kansas. We learn that they are at work upon the wheat in Kansas already, and are making their appearance in vast numbers in the southern part of this State, and as far north as Weeping Water."—*Omaha Republican.*

"*Kansas, about May* 24, 1867.—The Grasshoppers are already hatching out in vast numbers, and are devouring the winter wheat." —*Iowa Homestead, May* 20, 1867.

"*Leavenworth, Kansas, about May* 25, 1867.—The Grasshoppers are hatching throughout the country in myriads, and the same accounts come from other portions of the State. Within a mile of town considerable damage to spring wheat has been sustained, and below us, on the Delaware Reserve lands, their ravages are becoming serious. The leaves of the White Willow they seem particularly partial to, as they have stripped the young trees bare. They are not yet able to fly, but it is evident that they are good eaters."—*Leavenworth Conservative.*

"*Manhattan, Kansas, about May* 25, 1867.—The Grasshoppers, which have been the terror of our farmers for weeks, proving themselves impervious to water, fire and frost, are now finding an enemy we make haste to welcome as an ally. We refer to the beautiful blackbirds, immense flocks of which are luxuriating upon the hoppers, and returning thanks in exultant notes, and from throats almost splitting with joy."—*Manhattan Independent.*

"*Kansas and Missouri, about June* 6, 1867.—As regards Grasshoppers in Kansas and Missouri, of which innumerable eggs were deposited last autumn, and which greatly discouraged farmers, we learn that these eggs hatch out, and that in two or three days the Grasshoppers disappear."—*N. Y. Sem. Tribune, June* 11, 1867.

"*Nebraska, about June* 6, 1867.—Papers south of the Platte, where the Grasshopper plague was threatened, announce that the recent storm has cleaned the pest out wherever it prevailed. The *Nemaha* (Nebraska) *Courier* states, that great numbers of black-birds, plovers and other varieties of birds are gulping down the young Grasshoppers by wholesale quantities."—*Ibid.*

"*St. Joseph, Missouri, June* 8, 1867.—The [wingless] Grasshoppers, after doing serious damage to crops in this vicinity, are leaving —going west and southwest."—*Prairie Farmer,* July 13, 1867.

"*Jackson Co., Kansas, about June* 10, 1867.—The Grasshoppers threaten the crops; saw wheat-crops entirely ruined. Spring backward. Small grains look well where the Grasshoppers have not made their appearance."—"*W. M.,*" *in Prairie Farmer, June* 15, 1867.

"*Ottawa, Kansas, about June* 10, 1867.—When the Grasshoppers

first hatched out, they did a little damage to the young wheat and garden vegetables, but did no harm worth naming. Soon after hatching, they left the cultivated fields, and seem to have been disappearing ever since. I have a 25-acre field planted in young trees, which they are fond of, but they are all growing finely, and have not been injured, though millions of the 'varmints' hatched right among them. Moreover, I have cut within twenty feet of a park, where immense numbers of Grasshoppers hatched, a handful (?) of orchard grass two and one-half feet high, with no mark of a locust [grasshopper] tooth on it. The reports from other sections, so far as I can hear, are that they are disappearing without harming the crops, and nearly everybody is now satisfied that they will not injure us. What becomes of them all I can't tell. There are immense numbers of birds devouring them, and the general opinion is, that *they are dying off from some unknown cause.* The season has been rather cool and backward, as in other sections."—*S. T. Kelsey, in Prairie Farmer, June* 15, 1867.

"*Atchison, Kansas, June* 11, 1867.—We saw and conversed with a prominent citizen of Brown county this morning, and in conversation about the Grasshoppers he assured us, that on his farm one day this week he noticed thousands of young ones that had just hatched out, and in a very short time he noticed a large flock of blackbirds in the same place, which he discovered had effectually cleared out all the Grasshoppers, not one being left. He assures us that the prairie chickens and quails are eating them, nearly as fast as they hatch out on the prairie."—*Atchison Free Press.*

"*West Kansas, about June* 13, 1867.—With us Grasshoppers have at no time been so abundant, as in the more eastern portions of the State, and their advent was followed by great numbers of birds (mostly blackbirds), which have taken nearly all of the little pests, *and, at the same time, many fields of the late-sown wheat.* [When was it ever known that *blackbirds* devoured whole fields of young wheat?—B. D. W.] The blackbirds having done their work, have betaken themselves to other counties, and we find that new swarms of Grasshoppers are being hatched. So far as my observation extends, the wet, cold weather does not affect them either for good or evil, and we can only hope to be freed from them through their natural enemies, the birds. They are already so reduced in number, that we apprehend little or no trouble from them, unless they swarm from the east or west."—*N. Y. Sem. Tribune, June* 18, 1867.

"*Oskaloosa, Jefferson Co., Kansas, June* 14, 1867.—We have had a very backward spring. The grasshoppers hatched early in large

quantities, and are lively, industrious, and persevering. I think they will take all the wheat, oats and corn, if they do not leave soon. Farmers are very much discouraged.—"W. A. C.," in *Prairie Farmer,* June 22, 1867.

"*Leavenworth, Kansas, about June* 15, 1867.—The Grasshoppers are doing great damage on both sides of the Missouri River for a distance of 100 miles. Gardens and corn-fields are being devastated."—*Rock Island (Ill.) Union,* June 30, 1867.

"*Missouri, about June* 15, 1867.—The Grasshoppers have greatly injured the crops in Missouri."—*Corresp. of Chicago Tribune.*

"*Nebraska City, Nebraska, about June* 16, 1867.—The Grasshoppers, although hatching in countless millions, seem to scatter and disappear."—*N. Y. Sem. Tribune,* June 21, 1867.

"*Leavenworth, Kansas, about June* 16, 1867.—Something more than a week ago a farmer of this county informed us that the wingless Grasshoppers were gradually moving in a southerly or southwestern direction, and were averaging from a tenth to an eighth of a mile per day. We thought he might be mistaken, and mentioned it to one or two others, who, to decide it, determined to closely observe them for a week. They informed us yesterday that there is no mistake about it, and that all the young ones that are large enough gather in large bodies and steadily proceed south. One gentleman closely observed a particular body, and in a week's time they had progressed over two miles, which is doing pretty well, considering it was done by short hops. It does not seem to be for the purpose of procuring food, as they pass through a field of spring grain or other good pasture, as speedily as over naked plowed land. A field will be full of them one day, and the next not one can be found in it, except perhaps an occasional couple or stray. It is a curious movement, and worthy the attention of persons who are fond of investigating the mysteries of nature."—*Leavenworth Tribune.*

"*Leavenworth, Kansas, June* 25, 1867.—The Grasshoppers are making a clean sweep of every green thing in the gardens, throughout the southern and western portions of the city, and on the country farms beyond, so far as we have been able to hear. Millions filled the air yesterday, from 11 a. m. to sundown, without any apparent diminution of the numbers on the ground. As fast as their wings are developed, they take flight; and their course is steadily south-east. It will require a couple of weeks for all of them to become fully fledged, as those now here vary in growth from the size of a very small fly to that of the matured hopper. In the meantime, in this vicinity, the devastation of crops and vegetables is general and complete."—*Leavenworth Bulletin.*

"Kansas City, Missouri, June 26, 1867.—The Grasshoppers have taken up their line of march. Yesterday afternoon they were passing over the city in such millions, that it looked like a furious snow-storm raging in the heavens. They appeared to be at various heights —some seemed only like white masses against the blue sky, and others low down were lighting on the house-tops. They were going north-east."—*Kansas City Advertiser.*

"Peru, Nebraska, about June 30, 1867.—In October last the Grasshoppers came from the north-west, and covered this country and deposited their eggs. In the spring they began to hatch, and they have done much damage to the crops. Wheat and oats are mostly destroyed, and they are now working on the corn. At the end of the month they began to take wing, and soon the air became so filled with them that they appeared like fleecy clouds."—*Monthly Rep. Agr. Dep.,* 1867, p. 270.

"Holton, Kansas, June 30, 1867.—June 5th, Grasshoppers destroying the gardens in town; June 10th, [wingless individuals] passing by the million south-east; June 28th, on the wing, going north-north-east with the wind by the million; June 30th, getting scarce; supposed to be done here, or nearly so, unless they come from some other place. Some fields of wheat are eaten up, while others are not hurt."—*Ibid.,* pp. 269—270.

"Jefferson Co., Kansas, July 1, 1867.—A great deal has been said in the papers of this and other States of the devastation by Grasshoppers, but I have had good opportunity of noticing through this County and State, and consider the injury to wheat and rye to be not more than 1-20th of the crop. They are now flying, and ten days will relieve us of them in a great measure; and the injury by them has not been 1-100th part of what was anticipated three months ago." [Then, sir, your folks must have expected to lose 1-20th of their wheat and rye multiplied by 100, or 500 per cent. of the entire crop ! ! ! B. D. W.]—*N. Y. Sem. Trib. July* 16, 1867.

"Oregon, Missouri, July 1, 1867.—Farm and garden produce much injured by Grasshoppers."—*Monthly Rep. Agr. Dep.,* 1867, p. 305.

"Omaha, Nebraska, about July 3, 1867.—Grasshoppers are said to be very destructive to wheat and cereals south of the Platte River as far as St. Joseph, Missouri."—*Chicago Tribune, July* 6, 1867.

"Leavenworth, Kansas, about July 4, 1867.—In many parts of this State no Grasshoppers are reported, and the general testimony is that the crops never were better. They are having a high old time with Grasshoppers in Atchison Co., and fears for the onion crop are enter-

tained. The *Press* says that a full-grown Grasshopper was lately seen marching off with a good-sized onion under each wing, another lying across his horns, and with the tears streaming down his face, either because he was not strong enough to carry more, or because the onions he did carry were too strong for him."—*N. Y. Sem. Tribune,* July 9, 1867.

"*Jackson Co., Kansas, July* 8, 1867.—Such crops as have escaped the ravages of the Grasshoppers look well. The Grasshopper panic seems at an end. The most of them have taken flight to the north or north-west."—*"Bani" in Prairie Farmer, July* 30, 1867.

"*Padonia, Kansas, July* 8, 1867.—The prospects for crops here in north Kansas are very good now, notwithstanding the armies of Grasshoppers that were hatched here. Winter wheat that was not eaten up last fall is ready to cut. Spring wheat looks well; the Grasshoppers have injured it but little here. Corn also looks well, and, if the 'varmints' will only leave soon, will come out all right. Some think the Grasshoppers are leaving the country; there are not nearly as many now, as were hatched out last spring."—*"Young Farmer" in Prairie Farmer, July* 20, 1867.

"*Missouri, about July* 14, 1867.—Near St. Joseph the Grasshoppers have done some damage to the wheat, still the breadth sown was large and there will be an average crop. In the Phille Purchase, on the Western Border, the Grasshoppers have done great damage to everything but hemp."—*N. Y. Sem. Tribune, July* 19, 1867.

"*Nebraska City, Nebraska, about July* 14, 1867.*—In some localities the Grasshoppers have destroyed wheat, corn and garden vegetables clean. They have now finally left the State; gardens have been replanted and are doing well. Only the sandy portions of Kansas have been visited by this insect. In Otoe Co., Nebraska, the Grasshoppers have commenced their ravages on wheat, and it is suffering. Many fields will not be worth cutting, while corn is badly thinned. In some places potatoes are completely stripped. Sorghum has suffered much. Our gardens are eaten through and through. South of us we hear much complaint, while a few miles west there is little damage done, and in Cass Co., Nebraska the crops are very heavy."—*N. Y. Sem. Tribune,* July 19, 1867.

"*Omaha, Nebraska, July* 16, 1867.—The Grasshoppers have not done as much damage in this State as was expected. Their ravages

*In the original this item is not locally dated, further than as being intelligence from Kansas and Nebraska; but as it manifestly proceeds from the same pen as the third item which follows it here, I have given it the same local date. Without that local date, it is measurably unintelligible.

are most extensive along the Huerlano and Arkansas."—*Prairie Farmer,* July 20th, 1867.

"*Ottawa, Kansas, July* 22, 1867.—The Grasshoppers, what was left of them—perhaps one for every fifty that we had last autumn—staid here till their wings attained full size, and then got up and left. The damage they have done to this part of the country amounts to nothing. I am told that in some of the counties north of us they destroyed a little grain before they left."—"*S. T. K.," in Prairie Farmer August* 3, 1867.

"*Nebraska City, Nebraska, July,* 1867.—The season has been cold and backward, yet favorable for small grains, until the Grasshoppers hatched and commenced depredations upon our wheat, which has suffered tremendously. Many fields will not be worth cutting. Some fields of corn are badly thinned. Potatoes in some places are completely stripped, and our gardens are eaten through and through."—*Monthly Rep. Agr. Dep.,* 1867, pp. 244—5.

"*Richardson Co., Nebraska, July,* 1867.—The Grasshoppers have destroyed nearly all the crops in this county and are still at work."—*Ibid.,* p. 245.

"*Douglas Co., Kansas, July,* 1867.—The Grasshoppers have been doing much damage in this vicinity, to all kinds of vegetation."—*Ibid.,* p. 245.

"*Cass Co., Nebraska, August* 5, 1867.—The Grasshoppers have done no damage of any account."—"*A. G. B.," in Prairie Farmer, August* 10, 1867.

The migratory propensity is developed, from time to time, in the mature or winged Hateful Grasshopper in its native alpine home, whenever it has increased in numbers so greatly as to become instinctively aware that, if it deposits its eggs in the same district in which it was itself raised, its future offspring will starve. In the immature or wingless Hateful Grasshopper, *so long as it remains in a healthy state and finds plenty of suitable food at hand,* no such propensity would, I think, ever be developed, because it has not yet arrived at the time of life when the feelings connected with the reproduction of the species are called into play. Hence the fact, so often set forth in the preceding extracts, as well as elsewhere, namely, that the larvæ of those Grasshoppers, which had hatched out in the lowlands, in the spring of 1867, had already shown a premature propensity for migration, though they had plenty of good food at hand, seems to prove that they were in a diseased and unnatural condition. I feel confident, at all events, that no *healthy* grasshopper-larvæ would ever pass straight through a field of green grain, without stopping some

considerable time to take toll of it, as is reported above by the *Leavenworth Tribune.* (Page 117.) Hence, I infer that the whole brood of Hateful Grasshoppers, both young and old, throughout Kansas, Nebraska and Missouri, were, in the spring and summer of 1867, in a more or less diseased and abnormal state in consequence of the great change in the "Conditions of Life" previously referred to. (Page 112.) This accounts for the fact that, comparatively, so little damage was done by them, when we take into consideration the enormous numbers that hatched out. Likely enough, a very large proportion of them died a natural death, before they arrived at years of discretion, as indicated in some of the above reports, and in others that will be given hereafter.

The following excellent history of this pernicious insect appears to have been written about the middle of July, 1867, and is from the pen of Mr. W. F. Goble, of Pleasant Ridge, Kansas. It first appeared in the *Monthly Reports of the Agricultural Department* for 1867, (pp. 290—1.)

"These Grasshoppers, or Mountain Locusts as many call them, made their appearance in the western part of Kansas late in August, or about the beginning of September, 1866. The first intimation had here of their approach was the delay of the eastward-bound train, from Fort Riley and Manhattan, on account of the immense numbers of insects crushed on the track, thereby destroying the friction of the driving-wheels. About the 27th of the same month they made their appearance in Eastern Kansas, progressing at the rate of from 5 to 10 miles a day, or according to the velocity of the wind in the direction they travel. Their general course seemed to be from the north-west to the south-east. A contrary wind greatly impeded their progress, and when a strong breeze had to be overcome, they could not make any progress at all in their favorite direction, but generally remained on the ground rather than attempt to proceed, and spent their time in consuming everything accessible in the vegetable line.

"They travel in the air like bees, some flying at an immense height, as can be seen on a clear day by looking toward the sun. When first appearing in any particular locality it is in the manner of a cloud, the insects descending to the earth like dropping rain. They commence at once devouring all vegetable substances in their way, showing, of course, a preference at first. Vegetables possessing the property of sweetness in any degree, as green corn, sorghum, etc., escape till all others in the vicinity are consumed. But everything of an acid or sour taste, as cabbage, [?] or rhubarb, (pie-plant,) as well as bitter and even hot substances, such as tobacco and red or Cayenne

papper, are especial favorites. The tenderest vegetation is always destroyed first. Our fine crops of autumn wheat were completely eaten up in the space of two hours. They are known to eat nearly everything of the vegetable kind, even to the dry bark on trees, and dry lint of seasoned fencing plank, as well as dry leaves and paper and all kinds of cotton goods and woollen clothing; *and I have even seen a flock of sheep literally covered with them devouring the wool.*

"Soon after these insects came upon the ground, they concentrated along the roads and upon any bare earth they could find, preferring the short vegetation common in such places to the hard prairie grass. In such situations and in cultivated fields, the most of their myriads of eggs were deposited. They continued laying till the severe winter weather killed them. The eggs were deposited to the depth, generally, of one inch; although, in loose earth where vegetable roots were found, some were placed as far down as ten or twelve inches, according to the length of the root which was followed down and devoured, the Grasshopper emerging after having laid its eggs.

"On north hill-slopes the process of hatching was much retarded. It was supposed by the people generally, that the severe winter would utterly destroy the posterity of these creaures in this vicinity; but it did not, as the developments of spring fully testified, though perhaps not more than one-fourth of the eggs withstood the weather and produced Grasshoppers. Some of them commenced hatching as early as the last of February, when there were a few warm days, which brought forth those lying on the top of the ground. In March the weather was so severe, that a large proportion of the remaining eggs perished, the thermometer frequently indicating 18 degrees below zero. Judging from the voraciousness of those that did appear, *I doubt not Kansas would have been made a perfect desert if all had lived.*

"About the 10th of April the young grasshoppers began to appear in myriads, and farmers grew alarmed. In Salt Creek Valley, where the best farms of the State are located, not only are the ordinary grains devoured, but the finest timothy and blue-grass meadows are ENTIRELY KILLED OUT. Farms, however, lying next to timber and brush, fairly escaped, owing to the supply of vegetation thus afforded, and the constant fright given to the insects by workmen. When once driven from a place, they scarcely ever voluntarily return, as I demonstrated this spring in saving a garden and potato patch. This was done by taking bushes and driving the grasshoppers out at about 11 o'clock a. m., and again near sunset. They are very destructive during the night, and should always be driven off before sunset.

"I first noticed these insects on the wing this season on the 27th of June at Fort Leavenworth, when I saw a large number above the tops of the trees flying off in a south-easterly direction. Upon leaving the egg, they are of a milky white color and very tender. When they first began to appear in the spring, the cool nights destroyed many. *Indeed during the entire time they have been constantly dying by millions;* those that remained alive devouring the dead carcasses with the utmost avidity.

"No general damage has been done in the State this year by the grasshoppers, but some localities have suffered extensively. As before remarked, as soon as they had developed wings, they left us, apparently governed in their course by the wind. We are now quite free of them, and nearly as good crops will be raised as usual."

While passing down the Mississippi River by steamboat in the middle of August, 1867, I fell in with Mr. Fowler, a very intelligent farmer from the neighborhood of Chillicothe, Ohio, who, as he told me, had been travelling extensively through Kansas with the view of locating there, and, with business-like forethought, had been making particular inquiries everywhere about this Grasshopper-pest. According to my usual practice under such circumstances, I took down from his mouth the following very valuable information respecting the spring hatch of Grasshoppers in Kansas A. D. 1867.

"When the Grasshoppers hatched out in Kansas in the spring of 1867, they always, even before they acquired wings, kept working gradually in a south-east direction. After their wings had become fully developed, whenever the wind permitted, they took flight and flew in the same south-east direction; and if the wind changed, when they were already in the air, so as to prevent them from travelling south-east, they would immediately descend to the earth and wait for a change of wind. Swallows [thought to be Bank Swallows, *Hirundo riparia*] preyed very extensively on them, and so did the Blackbirds [*Icterus phœniceus*, Linnæus]; and a bird like a Night-hawk, usually found on the barren Plains to the west, followed them up and consumed numbers of them. After they had all disappeared, this last bird disappeared also. It was the general opinion of the farmers with whom I conversed, that, but for a six-weeks' spell of cold and wet weather in the spring of 1867, which benumbed the young Grasshoppers after they had hatched out, and probably destroyed many of them, *the entire crops of the country would have been ruined by them.* As it was, according to the closest estimate I can make, which however must only be considered an approximation to the truth, the Grasshoppers took, on the average, during the summer of

1867, in the parts of Kansas which I visited, 1-8th of the field-crops and 7-8ths of the garden-crops. The Dog-fennel [*Maruta cotula,* D C.?] they swept clean off everywhere; but that the farmers could very conveniently spare."

VARIOUS IRRUPTIONS OF THE HATEFUL GRASSHOPPER IN BY-GONE YEARS.

Usually—as is also the case with the Migratory Locust, (or, as we Americans should call them, "Migratory Grasshoppers,") of the Old World and of Scripture—these Grasshopper invasions only take place at distant intervals of time. For example, 46 years before the invasion of 1866, there was a swarm descended from the Rocky Mountains, A. D. 1820, upon Western Missouri, doubtless stopping by the way in Kansas, though, as that State was then uninhabited save by the Red Indians, we have no record of the fact. The following paragraphs afford all the information that I have been able to glean on this very interesting subject.

"We were informed by old residents of West Missouri and some of the Indians, that long ago, I think it was in the year 1820, there was just such a visitation of Grasshoppers as is now afflicting us. They came in the autumn by millions, devouring every green thing, but too late to do much harm. They literally filled the earth with their eggs, and then died. The next spring they hatched out, *did but little harm* (?), and when full-fledged left for parts unknown. Other districts of country have been visited by them; but, so far as I could learn, they have done but little harm after the first year."—*S. T. Kelsey, of Ottawa, Kansas, in Prairie Farmer, June* 15, 1867, p. 395.

"A Missouri Paper publishes a statement by an old settler, that great numbers of Grasshoppers appeared in September, 1820, doing much damage. The next spring they hatched out, *destroying the cotton, flax, hemp, wheat and tobacco crops;* but the corn escaped uninjured. About the middle of June they all disappeared, flying off in a south-east direction."—*Western Rural,* 1867.

Again: In the year 1856, or ten years before the invasion of 1866, and thirty-six year after the invasion just referred to, there descended from the Rocky Mountains another swarm, apparently of these same Hateful Grasshoppers, which—perhaps owing to the more northerly direction of the prevalent winds—took a more northerly course than the invading army of 1866 did, and swooped down upon Minnesota. In the *Practical Entomologist,* (II., p. 3,) I have printed all that I have been able to collect on this subject. Whether the damage said by the writer of that article to have been done by these in-

sects in Minnesota in the following year, 1857, was done by a fresh swarm descending from the Rocky Mountains, or by the individuals that hatched out from the eggs deposited in the earth by the swarm of 1856, is left uncertain. But I incline to believe in the latter alternative, because it seems improbable that, for two successive years, two successive swarms of Grasshoppers descending from the Rocky Mountains, should have been deflected so unusually far to the north of their customary line of flight as Anoka Co., in Minnesota. Besides, I see that W. E. Watt, of Minnesota, says that "the year after the Grasshoppers invaded Minnesota they did but little harm," thus evidently implying that there were not two successive years of invasion. (*N. Y. Sem. Tribune,* Feb. 1, 1867.)

Eight years afterwards, or A. D. 1864, there seems to have been another Grasshopper invasion of Minnesota, but only over a comparatively small region of country, and probably by some species distinct from the true Hateful Grasshopper. At all events, instead of appearing in September, they appeared in July; whereas, as Minnesota lies to the north of the districts usually invaded by the Hateful Grasshopper, we should expect that species to appear, if anything, rather later instead of considerably earlier than it always appears in more southerly latitudes. To whatever species these Grasshoppers belonged, they seem to have laid eggs, which hatched out the next spring in the invaded district, as the following extracts show:

"*Minnesota, July* 19, 1864.—A correspondent of the *St. Paul Press* speaks very alarmingly of the great Grasshopper raid now in progress down the Minnesota valley. They take every green thing in their course. We have no later news of the pests."—*Prairie Farmer, Aug.* 6, 1864.

"*Fort Ridgely,* (*on the Minnesota River*) *Minnesota, May* 24, 1865.—Our bright prospects are blighted by the belief that the crops will be destroyed by the ravages of the Grasshoppers. In many localities, the ground is completely covered with these little insects, and as small as they necessarily are at this early day, they have begun their work of destruction. I have seen small fields entirely ruined by them. Last spring (summer?) large armies of Grasshoppers started down from a point west and northwest of this, near the British Possessions, and in the autumn the frost found them in this section of country."—*Ibid., June* 3, 1865.

Whether the following extract refers to the winged grasshoppers developed in 1865, from the eggs laid in the Minnesota Valley in the summer and autumn of 1864, or to a fresh swarm winging its way into the State in 1865, from the west and northwest, I am un-

able to decide; but I rather incline to the former alternative. Clearly, this entire Grasshopper visitation must have been quite local; for, in the *Prairie Farmer* for 1865, may be found sundry "Records of the Season" from sundry parts of Minnesota, namely, Rice Co., Anoka Co., Ramsey Co., Goodhue Co., Blue Earth Co., Wabasha Co., Martin Co., Elgin and St. Paul, and dated from June 19th to October 7th, 1865, which say nothing whatever on this subject.

"St. Peter, Minnesota, July, 1865.—The Grasshoppers have been flying over this place in countless myriads. The air, for a quarter of a mile high, was filled with them, and their speed was four to five miles an hour. In every town or farm through which they pass, they leave a strong guard, and the destruction of crops is sure to follow."—*Prairie Farmer, July* 22, 1865.

Lastly, in 1857, as appears from the following extract, or one year after the first Minnesota invasion, and nine years before the great invasion of 1866, there was an irruption of some kind or other of Grasshoppers—perhaps our Hateful species, perhaps a different one—into the dominions of that High and Mighty Autocrat of a vast portion of the soil of Republican America, whom the vulgar herd of Gentiles designate as Brigham Young.

"In 1857, the Grasshoppers ate everything green in Salt Lake Valley, and came near starving the Mormons out, since which time old Brigham keeps one year's supplies on hand, knowing that they would not come the second year."—*Iowa Homestead, May* 8, 1867.

Ten years afterwards, as is shown below, there was still another irruption of the same insect, but apparently in greatly diminished numbers, into the same territory.

"Great Salt Lake City, Utah, about July 31, 1867.—The season has been very fine for farming, but on the last day of the month the Grasshoppers came by millions."—*Monthly Rep. Agr. Dep.,* 1867, p. 306.

"Wanship, Utah, July 31, 1867.—First appearance of a cloud of Grasshoppers over Wanship. They have destroyed one-half of the grain in Cache Valley, and all the fruit and a great amount of the grain in Davis Co. They are swarming on the lower part of Weber River."—*Ibid.*

"Great Salt Lake City, Utah, about November, 1867.—In a field that was being planted in the north-east portion of this City, last Monday, numbers of young Grasshoppers (the size of House-flies) were turned up by the plow, all alive and *green,* and quite recently hatched."—*Ibid.,* p. 365.

It is by no means certain, that the insect referred to in the above

six paragraphs is the same species as the Hateful Grasshopper of the other side of the Rocky Mountains. Indeed, as the young ones that hatched out *underground* from the eggs in November, 1867, are said to have been "green," while those that hatched out in Kansas from the eggs of the true Hateful Grasshopper in the spring of 1867, are said by Mr. Goble to have been "milky-white upon leaving the egg," (above, p. 123,) I should rather infer that it belonged to a different species, peculiar to the western slopes of the Rocky Mountains. If it be the same, its appearing in the winged state in Utah, A. D. 1867, nearly a month sooner than it appeared in the Valley of the Mississippi, A. D. 1866, may be accounted for, partly by the western exposure of the Rocky Mountains being perhaps warmer than the eastern exposure, which would, of course, have a tendency to accelerate the transformations of the insect, and partly by the invading army not having to march so far in this case to reach its "objective point." In the lowlands on this side of the Rocky Mountains, the average daily progress of the Hateful Grashopper, when full fledged, in 1866, was only, as we have seen, from five to ten miles. (Above, p. 121.)

THE LAST INVASION OF THE HATEFUL GRASSHOPPER IN THE AUTUMN OF 1867.

From the following extracts, which I have laboriously gleaned from various sources, it appears that, contemporaneously with the above invasion of Utah and just one year after the Grasshopper-invasion of Kansas, Nebraska and Missouri in 1866, and at least 42 days* after the last remnants of the descendants of that great army had finally wasted away and disappeared from the invaded territory, a fresh host of invaders descended upon the fertile plains of the Mississippi from the barren canons (kanyons) of the Rocky Mountains, and at precisely the same period of the year. This time, however, they took a rather more northerly course, the main body descending though Nebraska upon Iowa, instead of through Kansas upon Missouri. Still, in both years there were flying columns of the enemy, that deviated a little from the general line of march either to the right or to the left. For, as will be seen hereafter, some of the more northerly parts of Kansas and the extreme north-west corner of Mis-

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*As may be seen by the accounts collected from various sources and printed above, the departure of the Grasshoppers that hatched out in the spring of 1867 in Kansas, Nebraska and Missouri, from eggs laid in the preceding autumn, is variously dated in various localities from June 25th on to July 14th; while the earliest invaders in the autumn of 1867, as will be immediately shown, appeared August 25th, and the latest September 30th.

souri were invaded by the army of 1867; and, as I have shown in the *Practical Entomologist,* the southern parts of Nebraska were very generally invaded by the army of 1866. This second invading army, however, does not seem to have been quite as numerous as that of the preceding year.

It has been erroneously supposed by many, that this swarm of winged Grasshoppers, which made its appearance in Kansas, Nebraska and Iowa from August 25th to September 30th, 1867, was not a fresh importation from the Rocky Mountains, but simply the individuals that hatched out in the spring of 1867 from the eggs laid in the autumn of 1866 by the invading army of that year. But, in the first place, as I have already shown, there was an interval of, at the very least, 42 days, during which no ravages by Grasshoppers are recorded anywhere in the afflicted region—which pretty effectually demolishes the above supposition; secondly, one of the reports printed below expressly says that, for a period of $2\frac{1}{2}$ days,there was a constant influx of Grasshoppers into Richland, Nebraska, FROM THE NORTH-WEST; and thirdly, although south-western Iowa was really invaded in 1867 by some of the unfledged Grasshoppers from Missouri, yet this took place, not in the autumn, but early in June as the following paragraph shows:—

"The Grasshoppers are making sad ravages upon the crops of south-western Iowa. Whole fields of grain disappear in a single night. They go in large droves, and keep straight onward, no impediment whatever turning them from their course."—*Rock Island (Ill.) Union, June* 17, 1867.

Now, if the swarms that invaded Iowa in September sprang from the same source as those that invaded that State in June, why do we hear nothing of any Grasshoppers there from the forepart of June to the latter end of August? The truth of the matter seems to be, that the Hateful Grasshopper, in its native alpine home in the Rocky Mountains, attains maturity in August, and then, according to the mysterious promptings of its peculiar instinct, often takes wing for the far-distant lowlands towards the East; while the very same species, when hatched out in warmer climates, that is, in the lowlands of the Mississippi Valley, attains maturity towards the end of June, or fully one month earlier, and then, prompted by the same instinct that governed it in its native home, immediately takes wing, and usually flies off in a south-east direction; after which it perishes in some unknown manner.

"*De Soto, Nebraska, Aug.* 29, 1867.—Invasion of Grasshoppers,

looking like a snow-storm. They show preference for corn and potatoes."—*Monthly Rep. Agr. Dep.*, 1867, p. 311.

"*Glendale, Nebraska, Aug.* 31, 1867.—Grasshoppers now at work on the corn-fields; the blades and tops mostly gone; many stalks, three-quarters of an inch in diameter, cut off, and many ears just glazing eaten down, cob and corn, from one to two inches."—*Ibid.*

"*Richland, Nebraska, Aug.* 31, 1867.—At noon on August 27th large numbers of locusts [grasshoppers] appeared, and continued to come FROM THE NORTH-WEST until the evening of the 29th. They still (August 31st) remain, and it is probable that the corn will be almost or entirely lost."—*Ibid.*

"*Algona, Iowa, Sept.* 20, 1867.—Grasshoppers made their appearance in large numbers, and by the 30th had stripped gardens and tender herbage. Corn was too far advanced towards ripening to be much damaged. They seemed to come FROM THE WEST OR SOUTH-WEST."—*Ibid.* p. 352.

"*Council Grove, Kansas, Sept.* 26, 1867.—September 20th, Grasshoppers passing SOUTH-EAST in great numbers, dropping heavily of their numbers on farms and woodland. *All seem to be of spring* hatching. September 26th, laying eggs same as last autumn, and eating everything in their reach."—*Ibid.* p. 352.

"*Fort Dodge, Iowa, Sept.* ?0, 1867.—A swarm of Grasshoppers arrived at 1 P. M., September 10th, and commenced work immediately upon vegetables, leaving hardly any buckwheat worth cutting, and stripping the leaves entirely from the corn, so that it looks like sticks stuck in the ground. They came again in additional numbers on the 20th, but are now (at the end of the month) gradually decreasing. They have laid their eggs by millions."—*Ibid.* p. 352.

"*Holton, Kansas, Sept.* 30, 1867.—Grasshoppers eating some early-sown wheat. They can be seen by millions passing to the SOUTH-WEST. They have done but little injury here thus far."—*Ibid.* p. 352.

"*Greenwood, Iowa, Oct.* 6, 1867.—Grasshoppers pretty thick, but came too late in the season to injure anything except autumn-grain, of which there is very little."—"*Justice,*" *in Prairie Farmer, Oct.* 12, 1867.

"*Ottoe Co., Nebraska, Oct.*, 1867.—Of late, the Grasshoppers have again visited our section, and are depositing their eggs in vast numbers. We begin to fear that they may prove to be an annual pest to our River towns, and in fact to the entire Missouri valley."—*Monthly Rep. Agr. Dep.*, 1867, p. 327.

"*Osceola, Clarke Co., Iowa, Oct.* 20, 1867.—The Kansas Grass-

hoppers, which for six weeks past have gradually made their way EASTWARD, appeared here in comparatively small numbers about two weeks since. They are rather small brown insects, with red legs and white wings, to the general observer differing from the ordinary Grasshopper in nothing except their power of continued flight. A gentleman from the upper part of this county reports that, on a road running through his place, the Grasshoppers would be found, morning and evening, *six inches deep,* [in the ground?—B. D. W.?] He stated that their eggs were hatched after an incubation of several days, and that a few days' growth gave distinct form to the young. The female may be seen in large numbers on our roadsides in the act of 'setting.' The tail of the insect, projecting downward and backward, is found to enter a tubule in the sod, about ¾ of an inch in depth and 3-10ths in diameter. Into this nest is deposited an egg-sack of mucus, containing in uniform order 16 minute eggs of the shape of an elongated bean. I send a pair of insects and several nests of eggs."—*Corresp. of Keokuk (Iowa) Constitution.*

"*Des Moines, Polk Co., Iowa, Oct.* 30, 1867.—Myriads of young Grasshoppers have been observed in the fields about here of late, which of course must be the progeny of the flood of insects, which first made their appearance here the latter part of September."—*Iowa Homestead.*

"*Fort Calhoun, Nebraska, Dec.* 6, 1867.—Corn is about all in crib and not very good. The Grasshoppers took the leaves about 3 or 4 weeks too early, which affected it about the same as an early frost does."—"*C. R.,*" *in Prairie Farmer, Dec.* 21, 1867.

"*Nodoway Co., N. W. Missouri, about Nov.* 1867.—The Grasshoppers made a raid upon us this autumn, but too late to do much injury. We look for their appearance in the spring, when the eggs deposited will hatch."—*Monthly Rep. Agr. Dep.,* 1867, p. 365.

"*Woodson Co., Kansas, about Nov.* 1867.—The 'Mormon locusts' [Hateful Grasshoppers] made their appearance in this county on the 25th of September, and there was not sufficient cold weather to stop their ravages upon the crops until the 29th of October, when the thermometer fell to 24 degrees above zero. The consequence is that they have destroyed all the wheat sown prior to their arrival."—*Ibid.*

"*Dakota Co., Nebraska, about Nov.* 1867.—The Grasshoppers have left us, but their eggs have been deposited to be hatched out in the spring."—*Ibid.*

"*Hall Co., Nebraska, about Nov.,* 1867.—Grasshoppers have been

very thick again this season, but have done little damage. They have deposited few eggs compared with the preceding year."—*Ibid.*

"*Page Co., Iowa, about Nov.,* 1867.—We have been visited this autumn by the Grasshoppers, which have devastated gardens to considerable extent, and even eaten the fruit from the trees. They were particularly fond of peaches, in many instances eating the fruit entire, leaving the pit [stone] on the tree. Nearly all the cabbage in the county has been devoured by them, and the autumn wheat entirely eaten up, my own being the only piece left in this section. The earth is filled with their eggs."—*Ibid.*

"*Des Moines, Polk Co., Iowa, Jan.* 8, 1868.—There come to us from every direction expressions of great apprehension, about the devastations of the Grasshoppers the coming season."—*Iowa Homestead.*

When I was attending the Fair of our State Agricultural Society in October, 1867, I got into conversation at my Hotel with Mr. C. McKee, of Cass Co., Illinois, who, as he informed me, had just returned from a business tour through a great part of Iowa. From this gentleman I learned that the Grasshoppers first invaded Iowa about August 25th, and that they continued arriving till about the end of September. "They came," he told me, "with a westerly wind, and were generally believed by the Iowa farmers to have originated in Dacotah." He had met with them, or heard of them in the following counties of Iowa, and from the above Reports of the Agricultural Department we may add Adams and Page counties to the list; all of which, as will be seen by the geographical student, lie in the western half of the State, the most easterly point in the most easterly counties (Polk and Warren) being no less than 115 miles from the nearest point on the Mississippi River:—Cherokee (also reported by the Agricultural Department,) Woodbury, Ida, Sac, Calhoun, Greene, Dallas, Guthrie, Adair, Madison, Warren, Clarke, Ringgold, Carroll and Polk (Des Moines.) I may add that the Editor of the *Iowa Homestead,* to whom I had forwarded a list of the above 17 counties in Iowa, says in his issue of January 15, 1868, that he "thinks that the territory named covers the extent of the Grasshopper-raid into Iowa in the summer and fall of 1867."

Of course, throughout the districts in Kansas, Missouri, Nebraska and Iowa, which have thus been invaded by the Hateful Grasshopper in the autumn of 1867, the eggs laid by the females, except the few that hatch out the same autumn, will mostly live through the winter and hatch out in the spring of 1868; when, in all human probability, the same partial destruction of the crops will take place,

that was experienced in the spring and summer of 1867 throughout the districts invaded in the autumn of 1866. But there is not the least reason to anticipate, as the writers of many of the above extracts evidently do, that these Grasshoppers have become a permanent institution in that section of country. Likely enough these districts may not be again invaded by their little foes from the Rocky Mountains for the next ten or twenty years. When in October, 1866, in the columns of the *Practical Entomologist,* I stated that it was not at all probable that the Grasshopper plague would be continued in Kansas and Nebraska beyond the summer of 1867, I did so with the distinct proviso, "unless fresh swarms should descend upon those countries from Colorado." (Vol. II., p. 5.) Since, however, I am now writing more especially for the citizens of Illinois, it is not necessary to dwell further upon this subject.

But Kansas, Missouri, Nebraska and Iowa were not the only States on this side of the Rocky Mountains, that were invaded by Grasshoppers in the autumn of 1867. Nearly a dozen counties in Texas have suffered in the same manner and at the same time, and probably from the same species of Grasshopper, the portions of the State that lie at the greatest distance from the Rocky Mountains having been apparently not infested by these insects. I give below all that I have been able to collect on the subject.

"*Greenville, Hunt Co., N. E. Texas, about Dec.* 24, 1867.—Since the departure of those few dozen Grasshoppers, our farmers have begun to sow wheat in real earnest. The damage done by that same set of Radical bugs is not so great as was anticipated."—*Greenville Independent.*

"*Dallas Co., N. E. Texas, about Nov.,* 1867.—The Grasshoppers made their appearance here on October 17th, the air being filled with them. They appeared to be coming from the west, and traveling east. They have literally eaten every green thing, and in places where they got to the wheat that was being sown, they devoured the grain. About two-thirds of them have disappeared, and I think all will leave in a few days."—*Monthly Rep. Agr. Dep.,* 1867, p. 364.

"*Fannin Co., N. E. Texas, about Nov.,* 1867.—The Grasshoppers made their appearance about two weeks ago, but have done little or no injury yet. There is a general disposition to withhold seeding until they entirely disappear."—*Ibid.,* p. 365.

"*Red River Co., N. E. Texas, about Oct.,* 1867.—We have now in this county, for the first time in my recollection, a visitation of Grasshoppers, which are devouring everything they can make food of, and I fear they will destroy all the wheat put into the ground. Sowing will be suspended until they disappear."—*Ibid.,* p. 365.

"*Lampasas Co., Central Texas, about Oct.,* 1867.—Since my last report, Grasshoppers have come upon us, though not very numerous, but sufficient to deter farmers from putting in wheat and other small grains."—*Ibid.,* p. 365.

"*Lampasas Co., Central Texas, about Nov.,* 1867.—Grasshoppers made their appearance here in immense numbers about the 1st of October, and completely destroyed the autumn and winter gardens, and injured the stock range materially. They continued with us until the 20th, when they moved on their journey in a south-easterly direction. Many are deterred from sowing wheat by apprehension of the re-appearance of the destroyer in the spring."—*Ibid.,* p. 364.

"*Bell Co., Central Texas, about Nov.,* 1867.—We have had Grasshoppers in considerable numbers since the 15th of October, but too late to do any harm except to gardens, which they have entirely destroyed."—*Ibid.,* p. 364.

"*Coryelle Co., Central Texas, about Nov.* 12th, 1867.—The Grasshoppers made their appearance in this county on the 12th of October, coming in vast quantities from the north. They have been with us a month and done much injury. All the autumn gardens were destroyed; and though wheat-sowing is past, little has been sown, as the Grasshoppers eat the grain before it can be covered."—*Ibid.,* p. 365.

"*Lavaca Co., Central Texas, about Nov.,* 1867.—The Grasshoppers are already, in the western part of the county, depositing their eggs by the million, which, if not destroyed by storm or severe winter, will hatch out in the spring and do a great deal of damage."—*Ibid.,* p. 361.

"*Burleson Co., Central Texas, about Nov.,* 1867.—We have the Grasshoppers with us, and they cover the ground, and are depositing their eggs."—*Ibid.,* p. 364.

"*Fayette Co., Central Texas, about Oct.,* 1867.—Grasshoppers appeared in this neighborhood on the 3rd instant in great numbers."—*Ibid.,* p. 365.

"*Austin Co., Central Texas, about Nov.,* 1867.—Grasshoppers, hitherto unknown in this locality, have appeared in countless numbers."—*Ibid.,* p. 365.

In the following Table will be found a chronological synopsis of the various Grasshopper-invasions, of which the details have been given above. In every case eggs were deposited in the ground in great numbers, which, so far as can be ascertained, hatched out in the following spring, so as to cause considerable damage to the crops.

A. D.	Districts Invaded.	Species of Grasshopper.
1820..	Western Missouri (and Kansas?)	Hateful Grasshopper.
1856..	Minnesota	Hateful Grasshopper?
1857..	Utah	Unknown species?
1864..	Minnesota River Valley in Minnesota	Unknown species?
1866..	Kansas, South Nebraska, West Missouri and N. E. Texas.	Hateful Grasshopper.
1867..	Utah	Unknown species?
1867..	Texas (North-eastern and central counties)	Hateful Grasshopper?
1867..	Nebraska, North Kansas, N. W. Missouri and West Iowa.	Hateful Grasshopper.

The true Hateful Grasshopper must be carefully distinguished from the common Red-legged Grasshopper (*Caloptenus femur-rubrum, DeGeer,*) which swarms everywhere from Massachusetts to Minnesota, and from Pennsylvania to Illinois. The unpractised observer, indeed, would very readily confound the two species; for in reality they differ in nothing but the comparatively much longer wings of the former, which enable it to fly vast distances; whereas the latter does not usually fly more than a few yards at a stretch. Harris reports of the Red-legged Grasshopper, (or, as he prefers to call it, "the Red-legged Locust,") that in certain seasons it almost entirely consumes the grass of the New England salt-marshes, and then emigrates on to the uplands, devouring on its way grass, maize, garden-vegetables, potato-tops, clover and tobacco-plants. "These insects," he continues, "will even destroy in a few hours the garments of laborers, hung up in the field while they are at work; and, with the same voracity, they devour the loose particles which the saw leaves upon the surface of pine-boards, and which, when separated, are termed saw-dust." (*Inj. Ins.*, pp. 168—170.) As the reader will have noticed, the Rocky Mountain species has the same omnivorous propensities. It is probably to this Red-legged Grasshopper that Mr. S. T. Kelsey, of Kansas, refers, when he says that he "has known Grasshoppers in western New York to destroy a large proportion of the growing crops, and then deposit their eggs," as the other species did in Kansas in 1866. (*Prairie Farmer, June* 15, 1867.) While I was attending the State Fair held at Freeport in North Illinois in the year 1859, I heard (as I have already recorded elsewhere) from the farmers of that neighborhood great complaints of the damage done them that year by Grasshoppers. And Mr. Arnold, of DeKalb County, which also lies near the northern boundary of this State, says that his oat-crop in 1861 "was diminished at least 10 bushels per acre by the Grasshoppers, who ate off the heads, the ground being literally covered with grain."* In Fulton Co., Central Illinois, "myriads of young grasshoppers" are reported to have appeared "in the meadows,

*See, on these two points, *Trans. Ill. State Agr. Soc.* V. p. 497.

so as to be likely to destroy the crop of clover seed," on June 23, 1860. (*Prairie Farmer, July* 5, 1860.) And in Champaign Co., Central Illinois, young grasshoppers are said to have swarmed "in countless multitudes" in the middle of June, 1861. (*Ibid., June* 20, 1861.) All these grasshoppers in North and Central Illinois were also, in all likelihood, the common Red-legged species; and it is to that species that I should likewise refer the following observations, which, as well as many others that the reader has already perused, have been gleaned from the very valuable "Records of the Season," that enrich the pages of the *Prairie Farmer.*

"*Morgan Co., Illinois, Sept.* 7, 1867.—Some grasshoppers are eating on the leaves of the corn, but not enough to do any damage."—*Prairie Farmer, Sept.* 14, 1867.

"*Stark Co., Illinois, Aug.* 27, 1867.—Some grasshoppers are eating on the leaves of the corn, but not enough to do any harm."—*"W. N." in Prairie Farmer, Sept.* 7, 1867.

"*Marshall Co., Illinois, Sept.* 27, 1867.—Corn was doing well until the 27th of August, when THE GRASSHOPPERS made their appearance, eating off all the corn-blades and all our vegetables that grow above-ground."—*"E. S. H." in Prairie Farmer, Oct.* 12, 1867.

"*Washington Co., Illinois, Sept.* 3, 1867.—THE FLYING GRASSHOPPERS are here by the bushel; voracious eaters, they make fruit-trees, groves, currant and gooseberry bushes, and potato vines look bad indeed. Corn-fields look like fields of bean-poles with ears on them."—*"O. C." in Prairie Farmer, Sept.* 7, 1867.

Washington county, it will be observed, is in South Illinois, Morgan county in Central Illinois, Marshall and Stark counties in North Illinois; and all four of them are removed by the width of at least two counties from the Mississippi River. Consequently, it is unreasonable to suppose, knowing what we do of the habits of the Hateful Grasshopper, that that insect could have flown from the very centre of Iowa—the nearest point to Illinois where it is known to have occurred in the autumn of 1867—over the whole of the eastern half of Iowa and at least two counties in Illinois, without leaving any signs of its journey on the road, and have subsequently appeared in one or more of the interior counties of Illinois in September, 1867. Hence, so far as *indirect* evidence goes, it is utterly improbable that the Grasshoppers referred to in the above extracts could have belonged to the Rocky Mountain species. It is very true that there is no *direct* evidence, that the Grasshoppers found in Illinois in Marshall and Washington counties during September, 1867, by "E. S. H." and "O. C.," were not the veritable Hateful Grasshoppers of Kansas,

and Nebraska, and Western Missouri, and Western Iowa; and certainly their habits, as stated in the above two extracts, agree very remarkably with those of the Rocky Mountain insect. But who is to blame for this missing link in the chain of evidence? Not the editors of the *Prairie Farmer;* for no doubt they printed faithfully all the intelligence that their correspondents sent them. Not "E. S. H." and "O. C."; for they spoke according to the lights that had been vouchsafed to them. Not the Entomologists; for we have been preaching for the last ten years on the practical importance of our favorite branch of Science. The blame, in reality, lies with our wretchedly defective School System, which persists in tearing the brains of young children to pieces with such useless acrobat-feats of the intellect, as are dignified by the name of "Mental Arithmetic," while it utterly neglects to instill into their minds the commonest rudiments of Natural History. Hence we are perpetually dinned with nonsensical theories about "THE borer," "THE fly," "THE bug," "THE grasshopper," etc., etc., as if there was respectively but ONE species of borers, of flies, of bugs and of grasshoppers within the limits of the United States! Whereas in reality there are hundreds of distinct species of each of them, differing one from the other as widely as a sheep from a goat, or a cow from a deer, or a horse from a hog. Had but "O. C." of Washington county and "E. S. H." of Marshall county been familiarized in their school-days with these simple truths, they would not have thought it sufficient merely to chronicle the fact, that "THE grasshoppers" had done so and so in their respective neighborhoods; but they would, in addition, have sent specimens of the culprit insects to some competent entomologist—Mr. C. V. Riley, for example, who at that very time was conducting the entomological department of the *Prairie Farmer*—and thus it could have been decided with scientific certainty, to what particular species their grasshoppers really belonged. Would farmers but make it a rule to adopt this course, whenever they notice any unusual occurrence in the little World of Insects, they would not only put money into their own pockets by furthering our knowledge of Economic Entomology, but they might, in addition, often subserve the interests of pure theoretical science, by adding new facts to the great store which has been already accumulated. When the scientific name of an Insect has been once, no matter how, determined, the Farmer can record for all future ages with scientific precision whatever he knows about it; and the Farmer, be it remembered, is just as capable as the Philosopher of observing the peculiar habits of any particular species of Insects, and ordinarily he has much better and more fre-

quent opportunities for so doing than any Philosopher has. On the other hand, until the name of an insect is scientifically ascertained, everything that is said about it amounts to little more than guess-work, and groping round in the dark, and the balance of probabilities. We may, it is true, sometimes solve the scientific conundrum, as I have myself attempted to do in the present case, and *believe* that we have found the correct solution. But it cannot be too often repeated that, *"Believing* is not *knowing,* and *faith* is not *science."*

The practical man will, perhaps, think that, of whatever *theoretical* interest these long-winded discussions on the nativity of certain broods of Grasshoppers may be, they are of no manner of *practical* importance. But the practical man, if he so think, will be, for once in his life, mistaken. Let it only be conceded that Hateful Grasshoppers, after being raised from the egg in 1867 in the lowlands of Kansas and Missouri, can generate freely the same year in the lowlands of Nebraska and Iowa—for it must be remembered that the Grasshoppers that afflicted the two last-named countries in the autumn of 1867 are said to have laid millions of eggs—and no good reason can be given, why Hateful Grasshoppers, raised from the egg in 1868 in Nebraska and Iowa, should not generate freely in Illinois in the autumn of that year; and so on indefinitely for a long series of years. In other words, upon this seemingly mere theoretical question, that has been discussed at such tedious length, hangs the purely practical and highly important question, whether or not we folks in Illinois, and in other States still further to the east, are likely to be afflicted in the future by the Hateful Grasshopper for nobody knows how many years. If, on the contrary, every swarm of Hateful Grasshoppers raised in the lowlands is always barren, and if every swarm of them that is capable of laying fertile eggs must necessarily, as I firmly believe, have been raised from the egg in its native alpine home, away up in the canons (kanyons) of the Rocky Mountains, then there MUST be some geographical limit or other to the region of lowland country, which they are physically capable of reaching. It would be absurd, for example, to imagine for one instant that a Grasshopper-army, starting from the Rocky Mountains, could in one season fly all the way to France or England, or even as far as the Atlantic seaboard of the United States. Hence, allowing that there is some geographical limit to the flight of such an army, we have but to recur to historical facts to find what that limit has hitherto been; and we may then infer with moral certainty that for the future—all other influencing circumstances continuing the same—the geographical range of a swarm of

Hateful Grasshoppers, descending from the Rocky Mountains, will always continue to be the same or nearly the same.

It may perhaps be thought, by those who have not carefully studied the difference between the two cases, that, if the Colorado Potato-bug could descend from the Rocky Mountains into Nebraska and Iowa, and then pass onwards into Illinois, and so indefinitely forwards in its grand march to the Atlantic Ocean, the Hateful Grasshopper may do the very same thing. But the two cases are not parallel. The Colorado Potato-bug, as we all of us in northern and central Illinois know from woful experience, propagates freely and rapidly, generation after generation, in the northern lowlands of the Mississippi Valley, and spreads by this means every year further and further to the eastward; although it is very true that in the more southerly lowlands of that Valley—such as Kansas, and Missouri and South Illinois—it propagates much less freely and rapidly, and consequently spreads but very slowly indeed towards the east. On the other hand, superabundant evidence has been detailed in this chapter, to prove that the Hateful Grasshopper does NOT breed anywhere in the lowlands of the Mississippi Valley, but, on the contrary, gradually wastes away and disappears from off the face of the earth, when raised there from the egg, without itself laying any eggs at all. Therefore it is utterly improbable that this insect should, at any future period, breed freely in the country immediately to the west of the Mississippi, and thus pass gradually eastward into Illinois, and after breeding there pass on still further eastward. And in point of fact we know that the true Hateful Grasshopper has never been found by any entomologists, even in very small numbers, from one end of Illinois to the other. Moreover, the Colorado Potato-bug is a slow-flying insect, physically unable to fly across the vast Plains of the Western Desert at one fell swoop. Hence, until the distance between Colorado and eastern Kansas and Nebraska was bridged by settlements where potatoes were grown, it was incapable of passing into Kansas and Nebraska, and thence through Iowa into Illinois; and we know that history proves to us, so far as any negative fact can be historically proved, that it never did so. On the other hand, the Hateful Grasshopper is a rapid-flying insect, capable of flying hundreds of miles at a stretch, when caught up by a strong westerly wind; and there is historical evidence that it crossed the Plains, that intervene between Colorado and the inhabitable or eastern parts of Kansas, in 1820, or long before any white man had thrust his plow into the virgin soil of those two districts. Therefore, if this Grasshopper is going at some future period to make its way into Illinois,

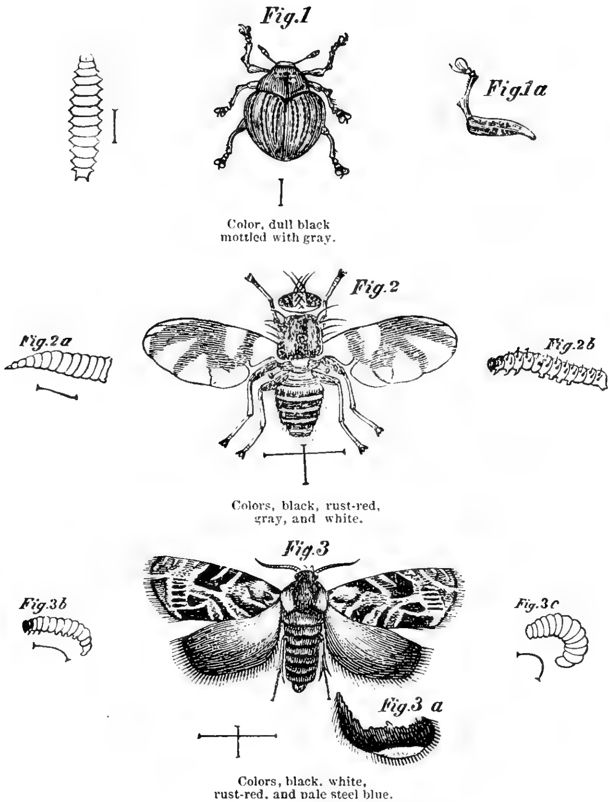
not by successive broods being raised one from the other on the route, but by one single uninterrupted flight from the Rocky Mountains, we have a right to ask, why it has never done so at some previous period?

Our State has now been organized for about 50 years, and for many preceding years it was sparsely inhabited both by the French and by the English. Yet, in all that long period of time, no record of any such Grasshopper-invasion of our State, as history shows to have repeatedly taken place in various States to the west of us, and in various years from A. D. 1820 up to the present year, 1867, can be met with in any printed document, or gleaned from the trusty memory of the "oldest inhabitant." Why is this? What possible cause can be assigned, why, up to the year 1870, for example, the Hateful Grasshopper should never have flown eastward from the Rocky Mountains within 115 miles of Illinois, and in that particular year should fly so many miles further east as to touch the sacred soil of Illinois? The distance from the alpine regions of the Rocky Mountains to the most easterly point that this insect has ever hitherto reached, namely, the centre of Iowa, is about 550 miles. What is to enable it at some future period to fly 150 miles further, or a total distance of 700 miles, which it must do if it is ever going to swoop down upon any considerable portion of Illinois from its present alpine home? It surely cannot be the settlement of some portion of the intervening country, that will enable it to do so. This cause, if it had any influence at all upon the length of its flight, would rather have a tendency to diminish that length; for there is abundant evidence that every invading army, composed of these Grasshoppers, drops a portion of its numbers, as it goes along, wherever it finds abundance of suitable crops to prey upon; so that, the wider the extent of settled country that it passed through, the sooner would such an army be reduced to nothing. The only physical change that I can conceive of, as likely to cause such an invading army to penetrate into Illinois, is a sudden upheaval to the amount of many hundred feet of the whole chain of the Rocky Mountains that lies to the westward of us, so as to bring the native alpine home of this insect full 115 miles nearer to Illinois. But modern geology teaches us that, although such an upheaval may very probably take place by slow and gradual steps in the course of the next 10,000 or 20,000 years, yet it can never come to pass in our time, or in the times of our grandchildren, or even in the times of our great-grandchildren twenty times removed. Therefore we may infer, with moral certainty, that no swarm of Hateful Grasshoppers can swoop down from the Rocky Mountains

upon Illinois, within the only future that practically concerns us. But it was demonstrated before, that this insect could not pass into Illinois in the same mode as the Colorado potato-bug has done, namely, by breeding at various way-stations on the road. Therefore, as there are but two conceivable modes by which the Hateful Grasshopper can reach Illinois, namely, 1st, at a single flight, or 2d, by breeding on the road, and as it has been shown that both modes are utterly improbable in the case of this species for hundreds of years to come, it necessarily follows that, in all human probability, it will not pass into Illinois at all for hundreds of years to come.

Every man—except, perhaps, some crazy Millerite—believes firmly that, in all human probability, the sun will rise in Illinois every morning for hundreds of years to come. Yet he has no better kind of evidence to justify such a belief, than I have to justify the truth of my theory, namely, that, in all human probability, we shall never for hundreds of years to come, be afflicted with the Hateful Grasshopper in Illinois. Both the inorganic and the organic worlds are governed by certain fixed laws; and whether it be a vast fiery globe of liquid lava revolving slowly upon its axis in the midst of the attendant worlds, that have been circling around it, each in its own peculiarly prescribed path, for indefinite ages; or whether it be some infinitesimally minute insect winging its way from the alpine heights of the Rocky Mountains over the Desert Plains of the West; we have but to ascertain by what laws each of them is governed, in order to be able to predict, in the case of each of them, what is, and what is not, morally certain to happen in the future.

THE END.



Drawn by BENJ. D. WALSH. Original cut engraved by WM. MACKWITZ.

Fig. 1. The Grape Curculio, (*Cæliodes inæqualis*, Say.)
Fig. 1a. Its front leg highly magnified.
Fig. 1b. Its larva.
Fig. 2. The Apple-maggot Fly, (*Trypeta pomonella*, Walsh.)
Fig. 2a. Its larva, the Apple-maggot.
Fig. 2b. The Apple-worm, (larva of *Carpocapsa pomonella*, *Linn.*)
Fig 3. The Plum Moth, (*Semasia prunivora*, Walsh,) female.
Fig. 3a. Part of the hind wing of the male Plum Moth.
Fig. 3b. Larva of the Plum Moth.
Fig. 3c. Larva of the Plum Curculio,(*Conotrachelus nenuphar*,Hbst.)

N. B. *The hair-lines show the size of the insect, when not magnified.*

FIRST ANNUAL REPORT

ON THE

NOXIOUS INSECTS

OF THE

STATE OF ILLINOIS.

BY WILLIAM LEBARON, M. D.,
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ERRATA IN FIRST REPORT.

PAGE 16,	14th	line	from top,	for "larvæ" read "larva."
" 20,	3rd	"	"	for "from" read "upon."
" 31,	5th	"	bottom,	for "with" read "in."
" 46,	12th	"	"	for "described" read "describes."
" 46,	15th	"	"	for "follows" read "follow."
" 51,	8th	"	top,	for "once" read "one."
" 57,	14th	"	bottom,	for "close" read "closely."
" 57,	8th	"	"	for "lying" read "flying."
" 88,	15th	"	top,	for "immovable" read "immovably."
" 93,	10th	"	"	for "of oyster" read "of the oyster."
" 96,	14th	"	"	for "superiors" read "superior."

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INTRODUTCION.

To His Excellency, John M. Palmer,
Governor of the State of Illinois:

Sir—Having been called by your appointment to fill the vacancy in the office of State Entomologist, caused by the sudden and accidental death of Benjamin D. Walsh, whose untimely loss scientific and economic entomology equally deplore, I herewith present my first annual report, in compliance with the requirement of the law by which this office was established, and in furtherance of the objects which my lamented predecessor had so much at heart.

My attention has been so much diverted, for several years past, from the study of insects, by the pressure of professional and other duties, that I have not been able, in most instances, to make those continuous observations which are essential to the complete elucidation of the history of species. The present publication, therefore, will be in the main, what its title implies, a report of my observations in practical entomology for the season just past.

The history of many of our noxious insects, and especially the most notorious of them, has been pretty thoroughly traced, not only by the entomologists expressly employed by several of the States for this purpose, but also by many other active gleaners in this field. Still, any one who enters upon the study of this extensive subject, soon finds work enough upon his hands. It cannot be said that the history of any insect is perfectly and absolutely known, and it is a notorious fact that some of the insects which have been longest known and studied, such as the Plum Curculio and the Apple Worm, are the very ones which are caus-

ing the most damage to the horticulturist at the present day; and if we take into account the multitude of insects which are preying upon our shade and ornamental trees and shrubs, which, in the estimation of many, are scarcely inferior in value to the fruit bearing trees, we may safely conclude that the prospect is very remote when the work of the practical entomologist will cease or materially diminish. And the force of this view is greatly enhanced by the occurance, every year, to a greater or less extent, of new species of noxious insects, or rather of insects which, having existed here or elsewhere in moderate numbers, from time immemorial, have suddenly sprung into destructive profusion in consequence of an abundant supply of congenial food, or the absence of their natural enemies, or other conditions favorable to life, some of which are known, and some of which are obscure or inscrutable. The Colorado Potato-beetle, the Currant Saw-fly, the Asparagus-beetle, and the *Bruchus granarius;* to which we might add the Pear-caterpillar (*Callimorpha Lecontei*), and the Lesser Apple-leaf folder (*Tortrix malivorana,*) treated of in the following report, were all unknown here as noxious insects until within the last few years. It is true that some noxious insects, on the other hand, have greatly diminished, and some, which have been the sorest scourges of the orchardist, such for example, as the notorious Bark-louse of the apple tree, seem to be in the process of extinction. But we must not draw too much encouragement from this state of things, since it is also true that noxious insects are sometimes known to disappear from one section of the country, only to break forth in greater number and virulence in another. The Chinch-bug, which at one time rendered the raising of spring wheat an impossibility in Northern Illinois for several years in succession, has, for many years, been wholly unknown in this section. And yet this very year it has again made its appearance in considerable profusion in a few localities, and I have recently heard of its having been found hybernating under the sheaths of corn-stalks in my own county of Kane; not in great numbers, it is true, but sufficiently numerous, I fear, to start a colony for the succeeding year.

Whilst it is the business of the scientific entomologist, in applying his knowledge to economic purposes, to test the value of the various antidotes which have been recommended against our in-

sect enemies, and if possible, suggest new ones, it is more especially his province to thoroughly study the habits and trace the development of the noxious species, so as to determine at what period of their existence, and at what time of the year, and to what part of the infested plant, the proper applications can be made with the most effect. For there is a period in the lives of most of our noxious insects, and that is usually, of course, the time of their tender infancy, when some one or other of the common remedies, such as soap, tobacco, lime or ashes, is effective in destroying them, provided only that it can be made to reach them.

In illustration of *the time when* such applications should be made, we may take two of the most destructive foes of the apple tree, the Round-headed borer and the Oyster-shell bark-louse. A single application of soap in the one case, and of soap diluted with water in the other, about the last week of May, or the first week of June, will be fatal to every insect which it reaches; whereas the same applications are utterly useless if made at any other time of the year.

In illustration of the importance of observing, in some cases, *the time of day* also, in which to make remedial applications, a good example is furnished by the Rose-slug, which hides under the leaves in the day time, and thus escapes our ordinary applications, but comes upon the upper surface to feed in the evening, and is therefore entirely exposed.

As regards the particular *part of the tree* to which to direct our remedies, a very good example is furnished by some observations which I have been making the past summer, upon the Bark-louse, or more correctly, the *Coccus* (*Mytilaspis*) of the pine, which, in this instance, stations itself upon the leaf. It is the habit of this insect, like most others of its family, to become stationary for life after the first few days succeeding its hatching; and it is the singular instinct of this species for the two sexes to fix themselves upon different parts of the tree, the males remaining upon the same leaves upon which they hatched, whilst the egg-laying females, which alone demand our attention, for the most part spread themselves upon the new and terminal foliage.

These, and many other examples of the above general propositions, will be found more fully elucidated in their proper places, in the following report.

In order to be able to avail ourselves of the knowledge accumulated by others, concerning the habits of our noxious insects, and the methods of counteracting their ravages, the first step is to identify with certainty, the species which we may have in hand. For this purpose, it is necessary to refer to some living authority, or to a correctly named cabinet, or to plates, or to well written descriptions.

Next to consulting some well informed entomologist, the surest way to identify an insect, is to compare it with the specimens in a well preserved and correctly named cabinet. With this end in view, it would be well for those whose pursuits render some knowledge of noxious insects especially important, to make private collections of their own. But as this is hardly to be expected, except in a few isolated cases, it becomes the more important that every horticultural society should have a well arranged collection of noxious insects, both in larva and perfect states, located at some central point where it would be easily accessible to its members, and others interested. But as such collections, also, will be most likely to be either wholly neglected or imperfectly prepared, we can understand the paramount necessity of having, at least, one if not more large cabinets in the State which may serve the purposes of ultimate resort. It was a pervading consciousness of this kind, no doubt, which produced so general a desire, on the part of intelligent men throughout the State, that the large and valuable collection of insects left by my predecessor in office, Mr. B. D. Walsh, of Rock Island, should be secured as the permanent property of the State. Soon after my appointment to the office of State Entomologist was publicly announced, I received communications from several persons of influence, and amongst others, Mr. W. C. Flagg, President of the Illinois Horticultural Society, calling my attention to this matter, and expressing the wish that this cabinet might be secured to the State. Mr. Flagg stated that he had already had two interviews with Gov. Palmer, in which this matter formed a principal topic of discussion, and that the Governor expressed his willingness to take any steps which might be necessary for the attainment of this end. Accordingly, as soon as it was determined that there would be a balance of the contingent fund at his disposal sufficient for the pur-

pose, Gov. Palmer authorized me to visit Rock Island and effect the purchase. Some of the details of this transaction were published in the newspapers at the time, and need not be here repeated. It may be stated in a few words, that this collection embraces all the orders of insects, that it is estimated to contain about thirty thousand specimens, well preserved and admirably mounted, and most of the species scientifically named; and that it was the result of ten years' assiduous labor by this able and enthusiastic entomologist. The price paid for it was twenty-five hundred dollars, which sum also covered a considerable balance of salary due to Mr. Walsh at the time of his death. I may here add that I have been both surprised and gratified at the universal expression of satisfaction by men of intelligence, wherever my official travels have carried me, at the accomplishment of this purchase, and I have heard no intimation that the sum paid for this cabinet was injudiciously expended. The cabinet is deposited, for the present, in the fire-proof building of the Chicago Academy of Sciences.

Next in value to a collection of the insects themselves, are correctly drawn figures. With respect to availability, a well illustrated book must even take the precedence of a cabinet, since the book can be obtained at a comparatively trifling cost, and may be always at hand. It is in this way that Mr. C. V. Riley, State Entomologist of Missouri, has done an excellent work in the cause of Western economic entomology. The figures with which his valuable Reports are illustrated, are remarkable for their accuracy, and one can never be at a loss, in referring to them, to identify any of the species illustrated.

And in this connection, I cannot help referring to the extensive and valuable series of plates illustrative of the entomology of the United States, and with special reference to the injurious species, in all their stages, in the course of preparation by Mr. Townend Glover, Entomologist to the Department of Agriculture at Washington.

The work consists of a great number of figures etched upon copper, many figures upon the same plate so as to economize space and material, and thus reduce the cost and price of the publication. The plates have already reached the following numbers: forty-five plates of Coleoptera, six of Orthoptera, seven of Neuroptera, ten of Hymenoptera, one hundred and nineteen of

Lepidoptera, six of Homoptera, five of Heteroptera, and eight of Diptera. Mr. Glover contemplates adding six or eight more plates of Coleoptera, and ten or twelve of Lepidoptera, to make the work as complete as possible. These will make, at least, two hundred and twenty-two plates, and as each plate contains twenty-five or more figures, we shall have here exhibited, at the lowest estimate, six thousand, five hundred and fifty illustrations of our North American insects. In addition to these, there are already completed, twenty-two plates of the cotton plant and the insects injurious to it. The drawing and etching have both been performed by Mr. Glover himself, and the whole work, as I understand, has been performed wholly outside of his regular office hours; a remarkable monument, certainly, to the zeal and industry of the author. This work, having been performed under such disadvantageous circumstances, the figures necessarily exhibit considerable inequality, in point of excellence, and many of them will have to be retouched before they are ultimately submitted for publication; but the author informs me that the whole work could be finished in a few months if he could devote his time exclusively to it.

The clause in the law by which the office of State Entomologist was established, which makes it a part of his duty to prepare a cabinet of the insects of the State for the Illinois Industrial University, has never yet been carried out. Mr. Walsh had accumulated valuable materials for this purpose, but no suitable provision has yet been made at the University to receive them. It is my intention, as soon as the work of preparing this Report is completed, to commence making up a collection, systematically arranged and named, both from Mr. Walsh's collection and my own, to be placed in temporary boxes, ready to be transferred to the museum of the Industrial University, whenever it shall be desired, and when suitable provision shall be made for their reception.

Most of the figures accompanying this report are reprints of figures prepared by Mr. C. V. Riley, for the illustration of his own Reports, or the pages of the American Entomologist. So far as I could avail myself of these figures, it answered my purpose as well as new engravings could have done, and they were obtained at considerably less than the original cost.

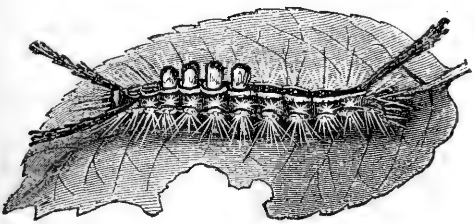
I take this opportunity to express my thanks to the officers of the great railroad lines throughout the State—the Illinois Central; the Chicago, Alton and St. Louis; the Chicago and Rock Island; the Chicago, Quincy and Burlington; and the Chicago and North-western railroads—for the annual passes over their respective routes, which they have freely presented to me.

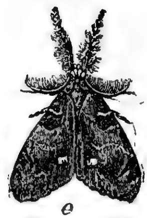
All which is respectfully submitted, by

WILLIAM LeBARON,

GENEVA, *Dec.* 15. *State Entomologist.*

INSECTS INJURIOUS TO THE APPLE TREE.





THE WHITE-MARKED TUSSOCK-MOTH.

(*Orgyia leucostigma*, Smith and Abbott.)

Order of LEPIDOPTERA. Family of ARCTIIDÆ.

Harris's Treatise, State Ed., page 366 ; Fitch's 1st and 2d New York Reports, p. 209 ; Riley's 1st Missouri Rep., p. 144.

There is no noxious insect which I have received from so many different localities during the past summer, as the pretty caterpillar, which is the larva of the above-named moth. It is easily recognized by its coral red head and neck, and two tubercles of the same color, on the ninth and tenth rings. There are four short, thick, brush-like tufts on the fourth and three following rings, varying in color from cream color to yellow, and three long pencils of black hairs projecting one on each side of the neck, and the other from the top of the eleventh ring. It is figured on plate seven, of Harris's Treatise, fig. one; and there is a better figure on the 145th page of Mr. Riley's first Missouri Report, a copy of which is given at the head of this article, and also a figure of the male of the moth which proceeds from it. This insect has always been described as an exclusively leaf-eating caterpillar, but in

almost every instance in which I have received specimens, complaint has been made of their gnawing the young apples, and examples of the fruit thus corroded have generally been sent in the packages with the caterpillars. The effect is either to destroy the fruit, or, where the corrosion is less in extent, to induce a deformity in its future growth. This kind of injury can only be done by the first or spring brood of caterpillars. The later brood will sometimes strip the tree of its foliage after the apples are nearly grown, and I have this year seen the curious spectacle of an orchard loaded with apples with scarcely a leaf to be seen upon any of the trees. The only injurious effect in this case seemed to be the diminishing somewhat the size of the fruit.

This is one of our most widely distributed insects, having been noticed in most of the States east of the Mississippi River. The female is wingless, and it could have obtained this wide geographic range only by being transported upon nursery trees from one locality to another. This is sufficiently explained by the fact that the female moth lays her eggs upon her cocoon, which is attached, sometimes to fences or other objects, but usually to the twigs of the tree upon which she has fed. If left to themselves, therefore, these insects would migrate very slowly, and in point of fact, are remarkable for committing their ravages within very limited ranges. For this reason they have never been regarded as noxious insects of a very serious character.

The Tussock-moth caterpillars are solitary in their habits; that is, they do not live together in families like the Tent-caterpillar and many others. This would render them very difficult to eradicate, were not their distribution limited by the wingless and stationary character of the female moths. They do not cover themselves with a web, but they have the power of letting themselves down from the tree by a thread, when disturbed.

These insects are remarkable for the great variety of foliage upon which they can subsist. Though they seem to prefer the apple, yet they feed freely upon the oak, maple, elm, plum, pear, horse-chestnut, black-walnut, larch, and rose-bush.

They pass the winter in the egg state, attached for the most part to the twigs and branches of trees, and as the egg masses are fastened to the outside of the cocoon from which the female has emerged, they form very conspicuous objects upon the leafless

limbs, and can therefore be easily seen and removed. Every orchardist and nurseryman should look over his trees in the course of the winter or early spring, and remove all the tufts of web or crumpled leaves which he may find adhering to their branches. In this way he will save himself from much loss, and also a great deal of labor in the subsequent and more busy seasons. He will thus remove at least two kinds of insects which are liable to become quite troublesome : the Tussock-moth caterpillar, now under consideration, and the Leaf-crumpler, often found disfiguring our apple and plum trees, and which is the larva of the *Phycita nebulo.* If this be neglected, the only way to get rid of them in the summer time, is to shake them from the trees. The foliage might also be made distasteful to them, by dusting it with lime when the dew is on.

Dr. Hull, of Alton, who has had much experience in the treatment of noxious insects, informs me that he has found the lime a very effective remedy, especially for the Leaf-crumpler. Indeed, the lime-dusting process is a sort of panacea, with the doctor, for destroying many of the foliage insects by which horticulturists are molested.

Another reason why the Tussock-moth larva has not been so destructive as many others, is that it is extremely subject to the attacks of parasites. Dr. Fitch describes two kinds of Chalcides which infest it, and Mr. Riley says he knows of seven others. And I have myself witnessed, this season, the most wholesale destruction of this insect, by parasites, that I have ever known in the case of any species. On the second of September my attention was called to an orchard a few miles from my residence, in which all the trees in one corner of the inclosure, to the number of fifteen or more, had been entirely stripped of their foliage by these caterpillars, whilst they were at the same time well loaded with fruit. The remaining trees, at least four times the number, were scarcely touched, illustrating, in a remarkable manner, the local restriction of the species. They had nearly all inclosed themselves in their cocoons, and were attached everywhere: on the twigs, branches and trunks, lying in masses in the crotches, and even on the sides of the trunk wherever there happened to be a little depression. In these cases, a number of cocoons, lying side by side, would sometimes have a sheet of web spread in com-

mon over the whole. Upon opening the cocoons, I found, with very few exceptions, not pupæ, but partly changed caterpillars, dead and dry, and in each of these two or three, and sometimes four coarctate pupæ, of a regular oval form and mahogany color, evidently belonging to some parasitic two-winged fly. In some were found the larvæ or maggots, not yet changed to pupæ.

They are from three to four-tenths of an inch in length, and present the ordinary characters of the larvæ of the Muscidæ or fly family. The body is somewhat tapering, anteriorly, and capable of considerable extension. The only parts of the mouth visible are two minute, curved, black mandibles or teeth. The body is rounded, posteriorly, with a shallow depression, in which are situated two conspicuous spiracles or breathing pores. On all the rings, but mostly on those nearest the extremities, are numerous microscopically minute, black, spinous points. These points extend all around the body, beneath, as well as above, and probably assist the larvæ in the slight locomotion which it requires. The pupa is a quarter of an inch long, with slight, but distinct segmental incisions, and even with vestiges of the spinous points of the larva, proving that the covering or case of what are known as coarctate pupæ is really only the skin of the larva contracted and hardened.

The parasitic flies began to emerge from their pupal cases during the first week of September, and proved to belong to the genus Tachina, proper, as restricted by Macquart, and to section A A A, distinguished by having the third joint of the antennæ a little more than twice the length of the second. They resemble the common house-fly, but are somewhat larger and have more bristly bodies. Many of the *Tachinæ* bear a close resemblance to each other, and are therefore difficult to distinguish from each other by merely verbal descriptions. This species may be appropriately named the *Tachina orgyiæ.* Length about one-third of an inch; sides of front, pale golden; middle space, velvet black; face, silver-ash; fascial bristles, reaching nearly to the middle of the face; eyes, bare; third joint of antennæ, a little more than twice as long as the second; second joint of the seta, well developed; third joint of seta, thickened for half its length; palpi, brownish; thorax, with alternate stripes of black and dusky cinereous. First longitudinal vein of the wings, after the auxillary, reaching the middle of the costa. Third and fourth veins, almost meeting, some way before the tip of the wing. Fourth vein, prolonged beyond the curve, half way to the border. Discal cross vein removed its own length from the border, and more than half its length from the flexure of the fourth vein. Abdomen black with cinereous reflections at the incisions and on the basal half of the segments, except the first. Two bristles on the hind margin of the first and second segments. Terminal segments many bristled.

Of the myriads of cocoons here accumulated, it appeared that scarcely one out of a hundred had escaped the fatal visitation of these parasites. So that the race of caterpillars, so abundant and destructive this year, may be considered as practically exterminated in this locality.

It might seem, at first sight, that a knowledge of parasitic insects is of no practical importance, inasmuch as they carry on their beneficent work wholly irrespective of our cognizance or co-ope-

ration. But a moment's reflection will show the erroneousness of this conclusion, of which the case now before us furnishes a sufficient illustration. Here is an orchard, one-fourth part of which has been devasted by these destructive caterpillars. The presumption is that their progeny, next year, will sweep the field. It behooves the owner, therefore, to set to work in earnest to collect and destroy this almost countless number of cocoons, and from any ordinary degree of search it may be reasonably feared that many will escape detection. But if he, or any one whom he may have it in his power to consult, knows enough of entomology to understand that all this work has been done for him by his parasitic friends, and much more thoroughly than he could do it, he is at once relieved from all labor and anxiety.

It was in the case of the larva of the Tussock-moth that I made the interesting observation, last summer, of the manner in which such birds as the American cuckoo contrive to eat the hairy caterpillars without filling their stomachs with indigestible material. Whilst sitting in the porch of Mr. Jesse K. Fell's residence in Normal, where I was visiting, with the *ad interim* horticultural committee, my attention was attracted to a cuckoo regaling himself upon these caterpillars which were infesting, in considerable numbers, a kind of imported larch which was growing near the house. My curiosity was excited by seeing a little cloud of hair floating down upon the air from the place where the bird was standing. Upon approaching a little nearer I could see that he seized the worm by one extremity, and drawing it gradually into his mouth, shaved off, as he did so, with the sharp edges of his bill, the hairy coating of the caterpillar and scattered it upon the wind. It has been long known that the American cuckoo is one of the very few birds that will eat the hairy caterpillars, but I believe that it has not been before observed how it is that he performs this useful part, without at the same time disturbing his digestion.

THE FALL WEB-WORM.

(*Hyphantria* (*Spilosoma*) *textor*, Harris.)

Order of LEPIDOPTERA. Family of ARTIIDÆ.

Harris's Treatise, page 357 ; Fitch's Report, No. 88.

This is the caterpillar which disfigures with its web, often several feet in extent, both garden and forest trees in the latter part of the summer and fall. Like other caterpillars of the family of Arctians, to which both this and the preceding species belong, they are very indiscriminate feeders. This is the more remarkable as the great majority of insects are very select in their diet, generally confining themselves to a single species of plant, or at most to plants of the same natural family. The Web-worm flourishes equally well upon the apple, pear, cherry, both wild and cultivated, shagbark and pignut hickory, black walnut, butternut, elm, ash, and willow, and they bear to be transferred from one kind of tree to another with impunity. I have, this summer, changed them from the apple tree to the black walnut, and *vice versa*, without their seeming to suffer any inconvenience. Their range of diet however has its limits. I have tried the experiment of tying nests of these caterpillars upon the common locust, maple, currant and rose bushes, and grape vine. In all these cases the caterpillars extended their web a short distance, but ate but little, and in no case came to maturity.

When young they eat only the upper surface of the leaves, but when more mature they devour the whole leaf except the larger ribs. They are active caterpillars, and when disturbed, have a habit, especially when young, of showing their dissatisfaction by snapping their heads from one side to another. They do not crawl upon the branches like the Tent-caterpillar, but travel along the threads of which their webs are composed. They inclose within their nests the leaves upon which they feed, extending their web from branch to branch as their necessities require. Late in the season these nests attain a great size, and where there happens to be a number of them on one tree, they will sometimes almost cover a tree of moderate dimensions. A nest of these insects upon an apple tree in my garden, the present season, which I left unmolested for the purpose of observing their habits, attained an extent

of seven feet by actual measurement. If a nest be torn open, the inmates in a short time repair the breach.

I have examined the nests upon different kinds of trees to see whether the difference of food produced any variation in the color of the caterpillars, but could discover none. This is the more remarkable as they are not a particularly uniform species, the insects in the same nest varying from a pale buff or brownish yellow to a dull green, but having in both cases somewhat of a grayish tint, produced by a dense sprinkling over the whole body of minute black points and lines. This intermixture of black is the densest on the upper side, so as to constitute a broad blackish dorsal stripe; but many individuals are scarcely darker on the back than on the sides. Drs. Harris and Fitch both describe the larva of *Hyphantria textor*, as having a black head. I have seen a few black-headed individuals in nests both on the apple and the hickory, but nearly all of them have heads of a clear amber-brown color. The upper lip and the basal joint of the small antennæ are pure white, constituting quite characteristic marks, irrespective of all other variations. There are five inconspicuous whitish lines extending the length of the body, one on the middle of the back and two on each side. The upper part of the neck is black or dark brown, divided through the middle by the white dorsal line. There are twelve pale orange or amber colored tubercles on each segment, the two middle dorsal and the lowest lateral ones being smaller than the others. The two larger dorsal tubercles are sometimes black, both in the darker and lighter colored individuals. Each tubercle emits a tuft of long hairs which are usually rusty-white, but in some specimens bright-ferruginous.

Many kinds of caterpillars conceal themselves, or at least remain stationary through the day and feed only in the evening or night. In this way, no doubt, they escape to some extent the notice of insectivorous birds, which are almost all diurnal in their habits. The caterpillars of which we are now treating are strictly nocturnal feeders. They remain in the oldest and densest part of their nests through the day, and notwithstanding their long fast, they do not venture out till it is quite dark. In order to witness them at their work I have been under the necessity of examining them by candle light.

The Fall Web-worms, as these caterpillars are usually called, have not heretofore been regarded as holding more than a third rate rank in the catalogue of noxious insects. Yet, judging from my observations the past season, I should suppose them to be upon the increase. I saw the apple trees much disfigured by them through the middle portions of the State, and also in my own neighborhood; and a correspondent of the American Entomologist, writing from Massachusetts, remarks that they have been unusually abundant in that part of the country. They appear so late in the season, not making much show till after the first of August,

that it is not probable that they will ever be very seriously injurious to fruit trees. The greatest objection to them is the disfigurement which their extensive webs produce both from fruit and ornamental trees. I do not know that any predaceous or parasitic insects prey upon them. Indeed they are so protected during the day, that it is not easy to comprehend how any insect enemies could get access to them.

An interesting question here presents itself, whether the parasitic insects are active in the night. We often see them plying their busy avocation in the day time, but the minute size of most of them precludes the possibility of our detecting whether they extend their operations into the night.

These are gregarious insects and are therefore easily removed by hand, or, where they are out of reach, by thrusting a pole into their nests and turning it round and round so as to entangle them in their web. Shaking and lime-dusting are here of no avail. One of my neighbors told me that he effectually removed them from his garden trees by tearing open their nests and sprinkling in some Paris Green with which he had been killing potato-bugs. But such applications are unnecessary. The true remedy consists in removing the nests by hand as soon as they make their appearance.

These insects pass the winter in the chrysalis state, and make their appearance in June and July in the form of white moths, without spots, with tawny yellow fore thighs and blackish feet, and measuring a little more than an inch across the expanded wings. A figure of the cocoon, and an imperfect one of the caterpillar, may be seen on plate VII, figs. 10 and 12, of Dr. Harris's treatise on insects injurious to vegetation.

THE LESSER APPLE LEAF-FOLDER.

(*Tortrix malivorana*, N. sp.)

Order of LEPIDOPTERA. Family of TORTRICIDÆ.

A pretty little bright-orange, round-shouldered moth, the larva of which is a small, greenish, naked caterpillar, with a pale amber-brown head and whitish incisions. In some specimens the

whole caterpillar is of a pale brownish tint. Usually, one caterpillar, sometimes two or three, eats off the upper cuticle of the leaf, curling the two sides upwards till the edges nearly or quite meet, and tying them together with web. In this inclosure the little caterpillar goes through its transformations. It lines the opposite sides of the leaf where the pupa lies with fine white silk.

Pupa three-tenths of an inch long or a little less; terminating anteriorly in a little knob attached by a neck. There is a series of minute points upon the edge of some of the segments, and the posterior extremity is furnished with two hooks, bent downwards, by means of which the pupa works itself half way out of the closed edges of the leaf before the moth emerges.

Moth three-tenths of an inch long, average expanse of wings half an inch. Antennæ brown, annulated with whitish on each joint, most distinctly on the under side, first joint densely clothed with orange scales. Palpi, orange, horizontal; the scales project around and beyond the end of the penultimate joint so as to form a little cup in which the small ultimate joint is inserted. Maxillary palpi rudimental. Tegulæ well developed, more than half as long as the thorax. Head, thorax and fore wings bright orange. The orange scales which cover the wings are observed when carefully examined, or seen through a lens, to be mixed with numerous whitish, almost silvery scales, so arranged as to form about ten indistinct, transverse sinuous or wavy lines. Hind wings, abdomen and legs whitish with silken lustre. There is a little plume of divergent scales at the end of the abdomen.

This little insect furnishes a very remarkable example of the sudden appearance and rapid multiplication of noxious species. The moth is so rare that I cannot learn that it has ever before been seen even by entomologists. There is not a specimen of it in the collections of either Mr. Walsh or Mr. Riley; and Mr. Glover, of Washington, who is himself an experienced lepidopterist and is familiar with most of the eastern collections, and to whom I had an opportunity of showing my specimens, said he had never seen it, and remarked that the species is so peculiar that he knew he should recollect it if he had ever met with it.* And yet this summer, in a single nursery of young apple trees, specimens enough could have been captured to supply all the cabinets in the world.

All I know of this insect I learned during a visit to the fruit farm of Mr. D. B. Weir, of Lacon, on the 22d of July. At some distance from the place my attention was arrested by the blasted

*Note.—Since writing the above Mr. Glover informs me by letter that he has recently had occasion to visit several of the large collections of insects in Philadelphia and Boston, and that he could find no specimen of this moth.

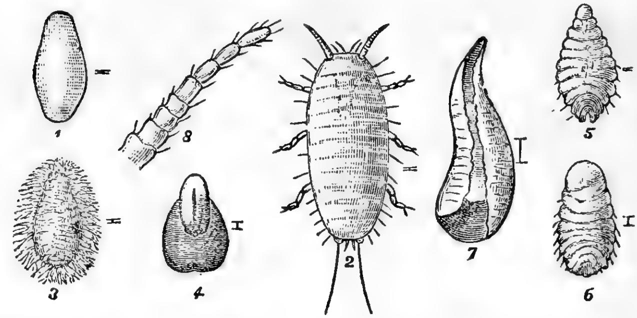
appearance of his apple nursery, the foliage looking, at a distance, as if it had been scorched by fire. Upon entering the inclosure, the authors of the mischief were readily detected. Upon putting apart the two halves of the folded leaves, a little worm could occasionally be seen, but at this date most of them had passed into the pupa state, and many of the moths had already emerged, so that a flock of them could be put to flight almost anywhere by brushing against the plants. Mr. Weir says that as little known as this insect seems to be, this is not the first year that they have injured his nursery.

There are at least two broods of this insect in a season. The first brood of moths, according to Mr. Weir, make their appearance early enough to deposit their eggs in the folds of the young leaves just as they begin to open. Another brood was just emerging, as I have above stated, in the third week of July. This brood, as Mr. W. afterwards informed me, by letter, began at once to deposit their eggs upon such leaves as had not been injured. According to my own observation, the caterpillars of the earlier brood draw the opposite edges of the leaf upwards, by means of their web, till they meet, thus forming a roof over the insect, which protects it from the weather, and must also serve to conceal it in a great measure from birds and other enemies. It must also form a serious barrier to the effective use of any destructive applications on our own part. But Mr. Weir informs me that the young of the last brood, hatching as they do on the surface of the mature and rigid leaf, do not draw its edges together, but simply protect themselves by constructing a web over the surface of the leaf. From the above account, it is evident that this little insect resembles, in most of its habits, the larger and more common Tortrix of the apple and the rose. In what form they pass the winter I believe has not yet been determined.

If this insect should spread so as to infest other nurseries, as it has that of Mr. Weir, it would prove itself a pest of the most serious character; and, as far as we can judge, from present appearances it will be a difficult matter to reach them with remedial agencies, both on account of the closure of the leaf in which they dwell, and their webby covering. Fortunately, as is the case with most other double-brooded insects, the first brood is comparatively limited in numbers; and Mr. Weir thinks it would have paid him

well to have gone through his nursery early in the season and picked off the folded leaves.

The importance of combatting evils in their incipient stages can find no more apt illustrations than in the department of economic entomology. Many noxious insects can be substantially eradicated in their infancy, which, if permitted to attain a larger growth and a wider spread, are wholly beyond our control. This is emphatically the case with the present species. It is evident that whatever applications we may make use of here, must be made before the young insects have time to close the leaf above them, in the case of the first brood, and before they have covered themselves with web, in the second. These periods will probably be found to be about the first week of May and the third week of July. But the time will vary some with the character of the season, and must be determined by actual inspection. These little worms are so tender and so unprotected by any hairy covering, that I should expect them to be easily destroyed by any of the ordinary applications, such as lime, ashes or soap, provided we can find a time when the substance applied will really reach them. Mr. Weir informed me that he discovered a bug with many bright stripes, preying upon these caterpillars, which from his description, I suppose to be the *Harpactor cinctus;* but this tribe of predacious insects is not usually sufficiently numerous to make much headway against such a multitudinous species as the *Tortrix malivorana.*



Explanation of figures—1, egg, scarcely one hundredth of an inch in length ; 2, young larva in its active stage ; 3, its appearance soon after becoming fixed ; 4, appearance of scale after the second plate is formed ; 5 and 6, insect at different stages, as seen under the scale ; 7, fully formed scale with inclosed insects, as seen from below : 8, antenna, highly magnified. The side figure shows the natural appearance of the scales on the tree.

THE OYSTER-SHELL BARK-LOUSE.

(*Mytilaspis conchiformis*, Gmelin.)

Order of HOMOPTERA. Family of COCCIDÆ.

Harris's Treatise, page 252 ; Fitch's 1st and 2d N. Y. Rep., p. 31; Walsh's 1st Ill. Rep., p. 34; Riley's 1st Mo. Rep., p. 7.

The common Apple-tree Bark-louse, obscure and uninviting as it at first sight appears, is, in many repects, one of the most anomalous and interesting insects that comes under the cognizance of either the scientific or the practical entomologist. How it is propagated, how it obtains its nutriment, and how it migrates from one tree to another ; whether it flourishes best on a healthy or a debilitated tree, whether it exercises any selection amongst the different varieties of apple, and whether, with respect to its prevalence, it is upon the increase or the decrease, are questions which have long been involved in much obscurity, and some of which are yet far from being satisfactorily solved. Yet it is an insect which has been long known, having been originally imported into this country from the other side of the Atlantic, and has been subjected to the prolonged scrutiny of some of th eacutest entomologists that either Europe or this country has produced.

It is one of the opprobria of entomology that the male of the Oyster-shell Bark-louse has never been discovered. Judging from the analogy of other species of the same genus, the male, if ever discovered, will be found to be a very small two-winged insect, yet having no special affinity with the dipterous order of insects.

The parts of the mouth are undeveloped, so that it takes no food, his sole office being the propagation of the species.

The female, on the other hand, with which alone we are acquainted, and which has been, upon the whole, probably the worst enemy that the orchardist, in the Northern States, has had to contend with, is a wingless, footless, eyeless, grub-like creature, which never moves from the spot where she first fixes herself, and effectually excludes herself from the light of day, by inclosing herself in an impervious cell, as it were, in a living sepulchre. And yet, though destitute both of the organs of vision and locomotion, these insects have passed from one continent to another, spread over vast States and Territories, crippled or destroyed thousands of orchards, and impoverished their owners, in spite of all the efforts and appliances which human ingenuity could devise. And the difficulty is increased when we consider that, with the exception of the first three or four days of their lives, they are immovably fixed to the bark of the tree. Can the mystery be solved?

In the first place, it is evident that this insect, if indeed it be identical with the European species, must have been brought across the ocean, attached to the bark of nursery trees. But it is far from being so easy to explain how it has been carried from one tree, and from one orchard to another, often at great distances apart.

Three theories have been suggested upon this subject; first, that the insects transport themselves during the short active period of their lives, by crawling from one tree to another. It seems to me that a very little observation must convince us that this theory is wholly untenable. If we compare the roughness of a piece of plowed ground, or the inequalities of sod land, with its growing grass and its complicated matting of last year's growth, with the microscopic minuteness of these insects, during the short active period of their existence, it will be obvious that they never could migrate more than two or three feet, at most, from the tree on which they grew, by any locomotive powers of their own.

Another theory is that they are carried from one place to another by adhering to the feet of birds, and possibly also to the feet and legs of larger insects. This was Mr. Walsh's theory, and it seems to be the only way in which we can account for their being carried to any considerable distance, such for instance as a mile

or more; and we often find them in isolated situations and under circumstances which preclude the idea that they could have been brought hither by human agency. For example, the Oyster-shell Bark-louse, being an imported insect, is never found, in a state of nature, upon our native crabs, and when they accidentally get a foothold upon them they do not multiply much, the crab tree being evidently uncongenial to their tastes. Yet I have seen them in small numbers upon every tree of a small grove of crab-apples which I have known for twenty-five years, standing upon the prairie, nearly a quarter of a mile from any apple orchard; and I have found a few scales on another crab-apple tree standing in the edge of the timber, more than half a mile from any cultivated trees. The bird theory, however, is a very inadequate one to explain the general diffusion of the Bark-louse. The most we could expect would be that a few of the insects might possibly be thus transported during the short time when they are not attached to the tree; and a series of experiments which I made, the past season, with the view of testing this theory, go to disprove the supposition that they are ever disseminated in this way. I wished to see whether these minute insects would readily crawl on to any obstruction like the toes of a bird. I experimented for hours by putting little slivers of wood about as large as a bird's claw in the way of the crawling Coccids, but in no instance would they crawl on to them. If the stick were put down abruptly before them, at a short distance, say one-tenth of an inch, they would usually stop and turn off in another direction, showing that they have the sense of sight. If it were put a little further off, so that they would approach it gradually, they would sometimes turn away before reaching it, and at other times they would come up to it, run along parallel to it, and if they could not find a place to get under it, they would turn away. I then beveled off the stick to a sharp edge, so as to present the least obstruction, and at the same time offer an inclined plane up which they could easily crawl, but they would not go on to it. It is pretty evident, therefore, that these creatures have no instinct which leads them to avail themselves of such means of transportation.

The third theory is that they are blown from place to place by the wind. That they are carried by a moderate breeze, during their hatching period, to a distance of several rods, has been abundantly proved by myself and by others. If you suspend an

inverted umbrella under an infested apple tree, at this period, you will soon see the little white crawling points upon it, being the more easily detected from their contrast with the black back ground. They can also be seen upon the grass or other objects under the tree by examining with a lens. They will uniformly be found further from the tree on the side towards which the wind is blowing than on the other. I have also found them thickly sprinkled upon the upper surface of cob-webs which happened to be spread over the grass at the distance of two or three rods from the tree. Being caught on the web, it was evident they could not have crawled there, but that they must have fallen there from above.

An interesting query here suggested itself as to the degree of tenacity with which these insects adhere to the tree at this period, and how strong a wind it requires to remove them. To determine this point I experimented by blowing upon them with my mouth, with different degrees of intensity. I found that a pretty strong current of wind did not disturb them, provided it was steady and uniform, but that a short, sharp puff readily dislodged them. At one time, during my examination, the wind arose and blew a pretty stiff breeze, and I could feel it sweep over the surface I was examining with considerable force; yet in only a very few instances could I perceive that any of the Coccids were blown off; and yet actual observation showed that the ground beneath was thickly sprinkled with them. The query arises whether these creatures may not have an instinct to loosen their hold upon the tree, irrespective of the force of the wind, for the purpose of dissemination. This may seem improbable, but it is no more wonderful than many of the instincts of insects.

A still more important question is, how far they can be transported by the wind. This will depend very much, of course, upon the force with which the wind may happen to be blowing, at any given locality, at the hatching period. At the time I made part of my observations, last spring, there was a pretty fresh breeze blowing, but I did not detect any Coccids upon the ground beyond about three rods from the extreme branches of the trees. Nevertheless, some of them may have been carried farther, for it must be borne in mind that it is not an easy thing to find such minute objects upon the ground, except where they are numerously dis-

tributed. Actual observation shows that these insects, small as they are, are decidedly heavier than the atmosphere, and that their tendency is to fall to the ground, at no great distance from the tree. That they are carried by the wind to great distances, under any ordinary circumstances, is extremely improbable. To produce this result we must assume the coincidence of a violent gale or hurricane, such as would very rarely occur at any one time year after year. And I repeat, lest it should be lost sight of by those who are not familiar with the history of this insect, that there are but three or four days in the year in which it is not immovably fixed to the tree. In view of the inadequacy of all the theories thus far propounded, it must be admitted that the rapid and wide-spread dissemination of the Apple-tree Bark-louse is yet involved in much mystery, and that such instances as the occurrence of the Bark-louse on the isolated crab tree above mentioned, remain to be explained.

The instrument by which this insect draws its nutriment from the tree, is in the form of a long and extremely slender proboscis or sucker, with a glossy surface and a redish tint, exactly resembling a very fine hair. It is so delicate and fragile that it is usually broken off in the act of removing the scale from the bark, and as it generally parts at its juncture with the insect's body, it escaped for a long time the notice of the most careful observers. Even so acute an entomologist as Mr. Walsh, so late as the time of the publication of his Report in December, 1867, although he presumed from analogy that such an organ must exist, and though it had been discovered and described by European authors in the case of allied species of the same family, nevertheless admits that "as to any organized beak he could discover nothing of the kind." And Mr. Riley, in his first Report, published a year later, says: "Though from analogy it must have a beak of some kind, it is so exceedingly fine and fragile, that I have never been able to perceive it." I had myself also examined hundreds of bark-lice without detecting the proboscis, and indeed did not see it till after I had discovered it in another and closely allied species, the *Coccus* of the pine leaf. I had noticed that in raising these scales, they did not always drop from the leaf, but sometimes hung fluttering from its surface, as if suspended by an invisible thread. This occurred so many times that my curiosity became excited to know

by what means it was thus suspended. Upon examining one of these pendant scales with a strong lens, I saw a fine hair-like filament, attached by one end to the leaf, and by the other to the insect's body, at that part of the breast from which the beak of Homopterous insects appears to proceed. The idea at once occurred to me that this was nothing other than the long-sought-for proboscis of the *Coccidæ*, and a little further inspection with the microscope proved the truth of the supposition. I immediately went into my garden and obtained some twigs infested by the Apple-tree Bark-louse, anxious to see if I could detect the corresponding organ in this species. It is astonishing how easy it is to find a thing when you know just where to look for it. I found that the proboscis of the Apple-tree louse exactly resembles that of the pine leaf species, and is just as easily detected. Subsequently, upon looking over some of the back numbers of the Transactions of the American Entomological Society, which I had not before seen, I noticed the article upon the Bark-louse, by Dr. Shimer, of Mt. Carroll. From this, it appears that he detected this organ in the course of a series of microscopic observations upon this insect which he made in the summer of 1867; so that to him must be given the credit of first discovering the proboscis of the Apple-tree Bark-louse, which for so long a time has eluded our search.

Fine as this organ is, it is found, when examined under the microscope, and under proper conditions of the organ itself, to be not the single hair-like sucker which it appears, but to be composed of several still finer pieces or filaments, which, though usually lying together, are capable of separation. The number of these pieces in the proboscis of the *Coccidæ* has been a subject of some diversity of opinion amongst European entomologists. M. Percheron, a French author who investigated these insects many years ago, stated the number to be three. Dr. Shimer also saw the proboscis of the common species separate into three pieces, for a part of its length, and I have seen it several times separate sometimes into apparently two and sometimes three parts. But Mr. Westwood says, that in some species which he examined, he detected four, and M. Signoret, who has very recently submitted the whole family of *Coccidæ* to a most rigid scrutiny, gives the normal number of pieces in the proboscis to be four. It is altogether probable therefore that the reason why we have not seen

this number in our species is that we have not happened to see them all separated. The length of this proboscis is also difficult to be ascertained, on account of its fragility, and the consequent doubt, in any case, whether we have extracted the whole of it from the bark. In my experience it has usually broken off, either close to the body, or of a length somewhat less than that of the body, though I have seen it considerably longer. M. Signoret says that in some species he has seen it twice the length of the insect's body, and in rare instances even three times as long. I once removed a young female of the pine leaf species (*Mytilaspis pinifoliæ*, Fitch) just as it was beginning to form the terminal shield, and when it was scarcely one-thirtieth of an inch long, in which the proboscis was two lines, or one-sixth of an inch in length, by actual measurement, and therefore fully five times the length of the insect's body. In this instance I noticed that the proboscis was filiform, or of equal thickness for the greater part of its length, and that it thence tapered to a very fine point, from which I concluded that I had succeeded in extracting the whole of the instrument from the leaf.

It is difficult to conceive how so delicate and fragile an organ can be inserted into the leaf, and much more into the tough tissue of the bark. I once succeeded in tracing the proboscis of the Pine-louse, for about half its length, running horizontally, just under the semi-transparent cuticle, and it is not improbable that this is the situation in which the instrument is usually introduced. Notwithstanding the sluggish and apparently almost lifeless condition of the female *Coccus*, the proboscis seems to be endowed with a special vitality. I have often seen it move with a waving or serpentine motion, and M. Signoret thinks it is capable of a considerable degree of extension and retraction, and it was some action of the attached proboscis, no doubt, which produced the jerking motion of the insect's body noticed by Dr. Shimer.

Upon the interesting topics of the difference of the sexes in this tribe of insects, and the nature and growth of the scale by which they are protected, we have made a somewhat systematic series of observations during the past season, but we have preferred to avail ourselves, for this purpose, of the species which dwells on the pine-leaf, for the reason that the existence and characters of the male of this species are known, and that the several parts

of which the scale is composed are so distinct and contrasted in this elegant species, that the investigation of it is much more practicable and satisfactory. We must therefore refer those who are curious in these abstruse and controverted branches of the subject, to the history of that species, at the end of this report.

We pass to a more practical question, whether the Oyster-shell Bark-louse flourishes best upon a healthy or a debilitated tree. This question also has its difficulties. For if the Bark-louse does not find the tree sickly, it makes it so, and as the two things always go together, it leaves an uncertainty which is the cause and which the effect. It is like the old question of the ague and the quinine: which it is that has damaged the constitutions of so many Western people. The popular hue-and-cry is against the quinine, which is a pretty good illustration of the danger of keeping bad company. We take the quinine only when we have the ague, and the two things becoming confounded in our experience, we perversely conclude that the disease is harmless and that the healing medicine does all the mischief.

That an insect, that lives by imbibing the sap of a tree, should flourish better upon a half dead and dried up tree than upon a thrifty and succulent one, is, on the face of it, extremely improbable. The conclusion to which I have come, both from reason and observation, is that if bark-lice get foot-hold upon a tree which is congenial to them, they will multiply and impoverish it, however healthy it may be at the time of attack, or however well the tree may be cultivated.

And this leads us to another question of considerable practical importance, and this is, whether the Oyster-shell Bark-louse exhibits any preference or exercises any selection between the different varieties of apple tree. That this is the case is, I believe the general opinion, and I am perfectly satisfied of it from my own observations. I saw the truth of this most satisfactorily illustrated in the orchard of Mr. Robson, of Galena. Here were trees some of which must be presumed to have been congenial, and others uncongenial to the insect, intermixed with the same inclosure, and the curious spectacle was exhibited of trees standing side by side, or alternating with each other, some of which were almost covered with scales, and others nearly or quite clear. These trees were so similarly situated with respect to all outside agencies that

it is difficult to conceive how they could have become so diversely affected, without supposing some selective taste or instinct on the part of the insects.

I have made some inquiries with the view of determining what varieties of apple tree are most infested by these insects, and what varieties are most free from them. There are some kinds about which the testimony is pretty uniform, whilst, as might be expected, some occupy a middle or debatable ground. Some of the varieties most largely infested are the Janette, the Yellow Bell-flower, the large Red Romanite, the Red Astracan, the Rambo, the Early Harvest, the Summer Rose, and several varieties of sweet apples. Some of those most free from the insect, are the Northern Spy, the Maiden's Blush, the Benona, the Soulard Apple, the Willow Twig, the Lowell and the Limber Twig, though with regard to the two last the testimony is conflicting.

The last of the questions propounded at the commencement of this article, was whether the Oyster-shell Bark-louse is at the present time increasing or decreasing in numbers. Happily for the prospects of the apple culturist, the uniform answer to this question from all quarters, at least from all those parts of the country where these destructive insects have most largely prevailed, is that their numbers are rapidly diminishing. This result has not been brought about by human agency, but by a reaction on the part of nature itself, whereby the excessive prevalence of this insect has been followed by a corresponding increase of its natural enemies, until these last have come vastly to preponderate, so that the notorious Bark-louse of the apple tree seems to be in a course of rapid extinction. The chief of these destroyers of the bark-lice are the *Acari*, or mites, and certain little roundish, footless maggots, which are the larvæ of little four-winged flies belonging to the family of *Chalcididæ*. The amount of destruction caused by the Chalcides can always be determined with mathemathical certainty; because we can either find the maggots under the scales, (except when they are very young and therefore not easily discoverable,) or we can see the little round holes through which the flies have emerged. By counting these and then comparing them with the whole number of scales on a given twig, we can estimate precisely the proportional number which the Chalcides have destroyed. But the work of the *Acari* cannot be so ac-

curately determined. Upon raising many of the scales in the fall of the year, we find them destitute of the eggs of the bark louse which should naturally fill them at this season. In their place we find a confused and discolored mass which we suppose to be the remains of the legitimate occupants, that is, the egg shells and the dried up body of the mother louse.

Amongst this *debris* the minute *Acari* are sometimes seen, and to them the ruin is generally attributed. But in most instances, so far as I have observed, no *Acari* are found, and some scales are almost wholly empty, so that if the *Acari* caused the destruction in both cases, they must, in the former instance, have done their work and left, and in the latter they must have devoured the mother louse, egg shells and all. But it is of no consequence to us who or what has wrought the ruin, so long as the bark-lice are destroyed. The important question is, what proportion of the bark-lice are destroyed, by any and all causes, and what part remain to propagate the race for another year?

Mr. Walsh, after examining many hundreds of scales in the summer of 1867, stated that the largest proportion which he had ever found with their contents destroyed, was two-thirds. From this form of expression we infer that it was only in certain cases, or perhaps localities, that so large a proportion were abortive, and this destruction he attributed solely to *Acari*.

The following observations will exhibit the matter in a more definite light.

On or about the twentieth of September, I examined all the scales on four twigs, taken from different trees, and from two gardens remote from each other, with the following result:

Whole number of scales	330
Number of scales with round holes, through which the Chalcides had escaped	116
Number of scales having under them the larvæ of the Chalcides	95
Number of scales, the contents of which have been destroyed by Acari, or unknown causes	85
Scales with ragged holes eaten by Coccinellæ	7
Scales containing more or less sound eggs	27
Whole number	330

Oct. 20th, examined four twigs taken from different trees:

Whole number of scales	284

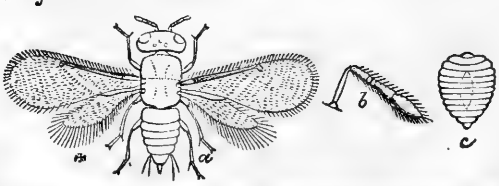
Chalcis holes	86
Chalcis larvæ	79
Acari, or unknown	102
Coccinellæ	2
Eggs	15
Whole number	284

Oct. 25th, examined a number of twigs obtained from different orchards in DuPage county:

Whole number of scales	230
Chalcis holes	87
Chalcis larvæ	70
Acari, or unknown	58
Eggs	15
Whole number	230

From this it appears that in the localities which I examined, more than twice as many bark-lice were destroyed by Chalcides, than by all other agencies combined. But the most important result is, that, of eight hundred and forty-four scales examined, only fifty-seven, or about one in fifteen, contained any eggs for another year's crop; and the case is really much more decisive than appears from the statement as it here stands, because I have included all the scales which had any eggs under them, though most of them were more or less damaged, and in some of them the Chalcis larvæ had commenced their work of destruction.

The history of this little Chalcis-fly furnishes one of the most interesting chapters in the literature of economic entomology. It had long been known to exist, by the smooth, round holes in the scales through which it had escaped. But it was not till the present season that I had an opportunity to trace the insect itself through its changes and witness the mode of its beneficent operations. I have drawn up a brief sketch of its history for the December number of the American Entomologist, illustrated by a figure of the fly and its larva.



Parasitic Chalcis of the Apple Bark-louse (*Aphelinus mytilaspidis*, nob.) *a*, fly; *b*, antenna; *c*, larva.

The following extract from this article presents some interesting observations not otherwise stated in the body of this report.

The causes which have been instrumental in producing the destruction of the Oyster-shell Bark-louse, and which are still operating to its completion, are matters of much interest. The agencies to which it has been usually attributed are the four following: Insectivorous birds; predaceous insects, especially the *Coccinellæ*, or Lady-bugs, and their larvæ; the larvæ of the parasitic Chalcis-flies, and the Mites, or *Acari*.

It has been generally supposed that the smaller insectivorous birds, such as the wrens and warblers, devour many of the eggs of the Bark-louse, but these eggs are so minute and so completely concealed under the bark-like scales, that even the sharp eyes of a bird could scarcely detect them, unless it were endowed with a special instinct for the purpose, and I know of no record of any actual observations which confirm this supposition. I am therefore inclined to the opinion that birds have done little or nothing in the way of exterminating the Bark-louse.

The *Coccinellæ* devour a very small proportion of these insects, whilst they are in their incipient and active state; but this lasts only three or four days, and therefore but very few of them can be thus destroyed. These predaceous insects, and especially their larvæ, also destroy a few of the bark-lice, in their subsequent stages, by gnawing ragged holes through the scales, and thus getting access to the insect beneath. Mr. Walsh conjectured that these rough holes were made by *Acari*, but I have repeatedly seen the larva of the Two-spotted Coccinella in the act of gnawing just such holes in the scales of the Bark-louse of the pine tree, and devouring its contents, and it is therefore probable that they are the authors of the similar holes on the apple tree. But the small number of scales eaten into shows that but few bark-lice are destroyed in this way.

The destructive work of the *Acari* is supposed to be indicated by the brownish, discolored remnants of the eggs from which the contents seem to have been extracted, easily distinguished from the pure white shells from which the insects have been hatched. Both Mr. Walsh and Dr. Shimer, who were the first to notice these mites, attribute much efficacy to their depredations, but that they are the sole authors of this work is rendered somewhat doubt-

ful by the fact, that in some localities, at least, where the scales containing these discolored eggs are not uncommon, the *Acari* are comparatively rare. Of eighty-one scales just examined (Sept. 26), containing these shriveled and discolored eggs, in only four were *Acari* seen. It is possible, however, that they may have left them after having extracted their contents.

But, besides the ragged holes above mentioned as the work of the *Coccinellæ*, a much larger number of scales are found through which has been bored perfectly smooth and round, or slightly oval, holes, which we know from analogy must have given exit to some parasitic fly. These holes have been particularly mentioned by several of our entomological writers, and must have been seen by all who have made a special study of the Apple-tree Bark-louse.

So long ago as the year 1855, Dr. Fitch, in his first Report upon the Noxious Insects of New York, gave a history of this Bark-louse, so far as it was then known, and mentions the frequent occurrence of these round holes in the scales at that time. He also discovered under some of the scales a little oval, footless maggot, which he conjectured might be the larva of some hymenopterous parasite, which, in its exit, made the holes in question.

In 1867, Mr. Walsh, in his history of the Bark-louse, in his first annual Report upon the Noxious Insects of Illinois, refers to Dr. Fitch's statement, and adds that he had often noticed the round holes in the scales, which he also attributes to the exit of a parasitic insect belonging to the Chalcis or Proctotrupes family. But he says he had never met with the larva described by Dr. Fitch.

In the course of a series of observations upon the Apple-tree Bark-louse, during the past season, it has been my good fortune to trace the history of this interesting little insect, which, if it has ever been seen before, has not been identified, and whose very existence has been only a matter of inference from the visible marks of its beneficent operations.

In the early part of the season, whilst examining the lice upon an apple tree, I noticed two or three little yellow Chalcides running along the infested twigs, which I conjectured might be the parasites of the Bark-louse, but had no proof that this was the case. But about the first of August, upon raising one of the scales, I happened to uncover one of these insects in the last stage of its transformation. Its wings were not yet unfolded, but it ran so

rapidly that I had some difficulty in keeping it within the field of the lens. As soon as it paused long enough to be examined, it was easily recognized as a Chalcis by its general aspect, and especially by the peculiar vibratile motion of its short, geniculate antennæ.

Having once become familiar with its appearance, I have had no difficulty in capturing, in the latter part of August and September, all the specimens I desired on the infested trees. I have repeatedly watched the female Chalcis in the act of inserting her ovipositor through the scale of the Bark-louse, for the purpose of depositing her egg in the cell beneath. She always places herself transversely with respect to the scale. Sometimes she mounts upon it, and then her tiny body is seen to be considerably less in length than the width of the scale. Usually she backs up upon it only so far as to bring the tip of her abdomen about opposite the middle of the scale. Then bringing her ovipositor down perpendicular to her body, she forces it through the scale by a series of boring or short plunging motions. Having accomplished this she remains stationary for many minutes, whilst by some invisible intestine motion the egg is carried down the ovipositor and deposited beneath the scales. So absorbed is she in this delicate operation, upon the successful accomplishment of which not only her own hopes, but those of the horticulturist, so largely depend, that nothing can deter her from it. In one instance, having drawn down a branch of an apple tree, I discovered a Chalcis in the act of depositing. Whilst holding the branch in one hand and viewing the insect through a lens held in the other, the branch slipped through my fingers and flew back with violence to its place. Drawing it down again, the twig I had hold of broke, and it flew back a second time. I supposed that that observation had, of course, been brought to an abrupt termination. But, upon drawing down the limb the third time, there stood my little Chalcis as immovable as a statue, at her post. She may be touched with the finger whilst thus engaged, or even crushed, as I have often inadvertently done in my attempts to capture her, but nothing short of this actual violence can move her from her position. With such wonderful perseverance and devotion do these living atoms of creation perform their allotted part in the complicated economy of nature.

The egg thus deposited hatches into the little footless larva previously mentioned. This larva is so admirably described by Dr. Fitch, in a single sentence, that I cannot do better than copy his description: "Under these scales I have repeatedly met with a small maggot, three-hundredths of an inch long, or frequently much smaller, of a broad oval form, rounded at one end and tapering to an acute point at the other, soft, of a honey-yellow color, slightly translucent and shining, with an opaque brownish cloud in the middle, produced by alimentary matter in the viscera, and divided into segments by faintly impressed transverse lines."

The only motion of which this small grub is capable is a slight extension and contraction of its body, particularly at the two extremities, by which its form is correspondingly modified.

There is usually but one larva under each scale, and I have never seen more than two. In the earlier part of the season it is seen adhering to the body of the Bark-louse, but later it is found in the midst of the eggs or their remains.

The Chalcis-fly itself is a beautiful object under the microscope. Its length is a little less than half a line, or about one-twenty-fifth of an inch, though I have captured a few specimens considerably smaller, being but little more than one-third of a line. I at first supposed that these smaller individuals were males, but all the specimens that I have examined have proved to be females. Their color is a uniform pale lemon yellow. The only variation from this color is in the minute mandibles, which are reddish brown. There are three coral red occelli on the summit of the head, and the ovipositor, which lies in a groove on the underside of the abdomen, exhibits a slight reddish tint. The wings are thickly beset, over nearly their whole surface, with bristly points, and their margin is ornamented with a long fringe.

But a better idea of the appearance of this little insect will be obtained from the magnified figures which accompany this article, than from any verbal description.

By observations, made as late as the first week in November, the opinion is confirmed that the Chalcis of the Bark-louse has two broods in a year. By the middle of September we find many of this year's scales pierced with the round holes through which the first brood of Chalcides has escaped; and late in the fall we find, under about an equal number of scales, the fully-grown larvæ

of the second brood, sometimes with the eggs of the Bark-louse upon which they have subsisted all consumed, and sometimes with a few remaining; and in this state they undoubtedly pass the winter. This second brood must appear in the winged form early enough next summer to deposit the eggs from which the first brood of next year will proceed.

The drawing made for the American Entomologist having been inaccurate, and the engraving imperfect, Mr. Riley kindly consented, at my request, to have a new engraving prepared, and the figure here given is a copy of the improved engraving.

From this general destruction of the Bark-louse, it would seem that its virtual if not total extermination must be near at hand. Yet it would be imprudent to permit ourselves to come to this conviction with too much haste or certainty, since it is a truth with which we have become painfully familiar, that noxious insects have their periods both of increase and decrease, and that some species, of which the Chinch-bug is a notorious example, have returned with renewed life and profusion after years of apparent extermination. One of the ways in which this is brought about, I conceive to be this: the numbers of a certain species having become greatly reduced by the operation of its natural enemies, parasitic and others, these, in their turn, being deprived of their appropriate nutriment, also become reduced in like proportion. The remnant of the former species, being, we may presume, naturally prolific, take a new lease of life and rapidly multiply again in all their former profusion. Judging from known facts and experiences, it is reasonable to suppose that such ebb and flow in the prevalence of particular species, are ever taking place in the multitudinous world of insects. Such reflections have forcibly occurred to my mind, as I have watched the parasitic Chalcis-fly of the Bark-louse, coursing busily over the branches, amidst the dry and empty scales, in search of some suitable pabulum in which to deposit the germs of her future progeny. Another circumstance which gives rise to some apprehension is, that these insects, within the last few years, have been found farther south than it has been heretofore supposed that they could subsist. I have received, this year, infested twigs from Mr. A. C. Hammond, of Warsaw, as far south as the northern border of Missouri. And I was informed at the horticultural meeting at Mr. Flagg's, near Alton, on the sixth of October, that the Oyster-shell Bark-louse

was known to exist, and was thought by some to be on the increase in that section of the country. And, furthermore, it appears from the correspondence of the American Entomologist, that this insect has been found even so far south as the State of Mississippi. The question therefore arises, with considerable pertinency, whether this destructive insect may not be disappearing from the north, only to enter upon a new career in the more southern latitudes. All I can say in answer to this question is, that this has always been regarded as an essentially northern species, and, therefore, it is supposed that it will not multiply to any great extent at the South. A little circumstance, incidentally mentioned by Mr. Walsh, gives us additional encouragement. He states, in a note to his report, that he received some branches infested with this insect from Mr. Huggins, of Macoupin county, and that upon examining them he found that in nineteen-twentieths of them the contents of the scales had been destroyed, as he supposed, by *Acari*.

It is not necessary here to go into a detailed account of the various remedies that have been resorted to for the purpose of destroying this insect. Mr. Walsh instituted a thorough series of experiments in this matter, and has given us the results in his treatise upon the Oyster-shell Bark-louse, in his first report. To that I refer those who are interested to know the past history of the treatment of this pest. The essential and universally approved remedies can be stated in a few words. The treatment is of two kinds: that which is appropriate on or about the first of June, when the lice are young and tender, and that which may be applied at any time in the winter or early spring, with a view of destroying the eggs under their protecting scales. At the former period, much weaker applications, of course, are successful than in the latter, and we are necessarily restricted to such on account of the danger of injuring the young foliage. Various kinds of narcotic and alkaline washes have been tried for the purpose of destroying the lice in their incipient stages, but the most effectual of all is common soap-suds. This has to be used of different degrees of strength, according to the part of the tree to which it is applied. Undiluted soft-soap can be applied to the trunk of a tree of considerable size, without injury; on the smaller branches it is better to dilute it to the extent of from four to six parts of water to one of soap; and on the young shoots and foliage it must be very largely diluted, not exceeding two or three cups of soap

to a pailful of water. Even of this strength it discolors the foliage, but does not kill it. The one great difficulty in the way of exterminating the bark-lice, is their habit of spreading on to the terminal twigs. Here they do most of their mischief, and here it is most difficult to reach them, and we are debarred from using very efficient washes on account of the tenderness of the foliage. The practical rule is this: with a whitewash brush wash over the trunks and branches of the trees as far as you can reach, with the strong solution, one part soap to four of water; then syringe the remainder with the weak solution, two or three cups of soap to a pailful of water. The strong solution will kill every louse it touches, and the latter, according to Dr. Mygatt's experience (Trans. Ill. St. Agricult. Soc., I, p. 516), will kill about half of them. But this is the best we can do, unless we take a dull knife and scrape every twig, which might be done on one or two very small trees, but would of course be utterly impracticable in an orchard. The above course, to be successful, must be put in practice when the young lice have just hatched, or within a few days thereafter. This time varies two or three weeks, according to the character of the season. The usual time is the last week of May or the first week of June. But this year they began to hatch, in the latitude of Chicago, on the 15th of May, the season being unusually hot and dry. The only way to be sure is to watch, and examine the trees at this time of the year with a pocket lens, each one for himself.

But the great desideratum is something that will kill the eggs through the scale, without injuring the tree, and which can therefore be applied in the winter or early spring, when farmers are most at leisure, and when there is no foliage to be damaged. No such application, at the same time safe and effectual, has been discovered. The scales are sufficiently thick and impervious to protect the eggs beneath from any of the ordinary applications. Even undiluted soft-soap does not affect them. Greasing over the infested branches with any kind of oily substance, is sure death to them, but it is questionable whether it does not also injure the tree. Mr. Walsh collected much testimony upon the subject, but it is very conflicting. Some say that it killed their trees, whilst others assert that it does not injure them. Even if the greasing process were unobjectionable, there would still remain the difficulty

of applying it to the extreme branches. Mr. Walsh attempts to explain why oily applications are more effectual than washes, by saying that nature has made the scales of the Bark-louse water-tight, but did not think it necessary to make them oil-tight. It is a sufficient explanation, and I think a more probable one, that greasy applications destroy all life beneath the scales, simply by rendering them impervious to the air.

There is one application from which I had been led to expect the most satisfactory results from the strong testimony I had heard in its favor, and this is fish brine—being the refuse liquid in which mackerel and other fish have been pickeled. This possesses two of the essentials of a universal remedy, namely cheapness and a liquid consistency, so that it can be thrown with a syringe over all parts of a tree. I visited the orchard of Mr. John Robson of Galena, and saw the trees upon which the experiment with this substance was, I believe, first made, some three or four years ago, and about which a good deal was said at the time. It was asserted that the scales peeled off from the branches to which it was applied, leaving the bark uninjured. I found the trees in a clean and healthy condition, but some doubt was thrown over the special efficacy of the application, by the fact that other trees standing near them, and which had been treated with common alkaline washes, were about equally clean. I made some experiments with this remedy upon some infested trees in my garden, about mid-summer, after the scales had become fully formed, but a little before the time of depositing eggs, by dipping the ends of the branches into a solution, such as Mr. Robson made use of, namely, one pint of the brine to two gallons of water. If the application were effectual it would of course arrest all future development of the insects beneath the scales, and consequently no eggs would be found deposited. All such experiments have been rendered very unsatisfactory the present season by the almost universal destruction of the bark-lice and their eggs, as previously related, by parasites. But truth compels me to state that I certainly found scales filled with sound eggs on the branches thus treated, very few, indeed, but about as many as the Chalcides and other parasites had left on the other branches. I suspect that whatever virtue the fish brine may be found to possess, is due to the oil with which it is largely impregnated. And even in this point of view it may prove to be a valuable remedy by furnishing a cheap and

available means of applying oil in a diluted form. But as the proper time to apply this remedy is in the winter or early spring, when there is no foliage on the trees, it could undoubtedly be used much stronger than it was in Mr. Robson's experiments and mine.

I cannot close this chapter, already, perhaps, too long, without briefly referring to a subject of the utmost interest and importance, and one directly suggested by the foregoing history, and that is, the practicability of transporting beneficial parasites from one part of the country to another, or if necessary, importing them from abroad.

The incalculable benefits resulting from the depredations of parasitic insects upon those kinds which are injurious to mankind, are now generally known, and they can have no more striking illustrations than those furnished by the history of the Chalcis-fly in a former part of this chapter, and the parasitic Tachina of the Tussock-moth, described in the first article of this report. It is also a notorious fact that many of our most pernicious insects have been imported from abroad, and one reason why they have proved so intractable, is, that in introducing the noxious insect, we have failed to import with it the natural enemies which held it in check. Mr. Walsh was so impressed with the importance of this subject that it became almost a hobby with him, and he went so far as to advocate the artificial breeding of parasitic insects, if they could not be otherwise obtained. However difficult this might be in ordinary cases, since we should also be obliged to rear the noxious species upon which the parasite subsists, yet that the transportation of them, at least, is not necessarily impracticable, is very clearly shown by the case of the Chalcis of the Bark-louse. One brood of this insect passes the winter in the larva or pupa state under the scale of the Bark-louse, at whose expense it has subsisted, ready to emerge on the opening of the succeeding summer.

The twigs of apple trees, where the Chalcis is known to abound, could be easily gathered any time in the winter or spring, and carried to any other part of the country, or even to a foreign land, and all that would then be necessary would be to tie these twigs, here and there, upon the branches of the trees which it is desired to protect. That this operation will ever have to be performed with this particular species, is not, perhaps, very probable, but

the case is none the less interesting, as showing that parasitic insects, even of the most minute character, can be transported, in some instances, with perfect ease and certainty, and should caution us against dismissing the whole subject from our minds, as we have been inclined to do, as impracticable and absurd.

POSTSCRIPT.

Since writing the above, my friend Capt. Edward H. Beebe, of Galena, procured and transmitted to me (Nov. 8) a number of apple twigs, obtained partly in that town and partly from the Southern part of Wisconsin, a section which has suffered more from the depredations of the Bark-louse than almost any other locality. A very brief inspection of these twigs was sufficient to show that our infinitessimal friend, the Chalcis, has not yet found its way to that region, or at least not to that particular locality. Not a trace of it could be discovered, either by the round holes in the scales or the presence of the larvæ beneath them. The disappointment, however, was somewhat mitigated by finding that more than two-thirds of the scales are, nevertheless, from some cause or other, abortive. Upon carefully raising and examining two hundred scales upon six different twigs, sixty of them were found to contain sound eggs of the Bark-louse, and one hundred and forty were abortive. These abortive scales present the same appearances that such scales have when obtained from other localities; that is, a small proportion of them contain only the thin and dried remains of the female Bark-louse, who has perished from some cause, without depositing or perhaps even forming her eggs. But most of the scales exhibited the brownish, granulated mass which they generally contain, and which we may presume to consist of shrunken and discolored eggs. This mass of *debris* also has, in most cases, a furry aspect, which is probably owing to mould.

The interesting question here arises, what, in the absence of the Chalcides, has caused the destruction of this large proportion of the bark-lice and their eggs? I searched carefully for *Acari*, and lest, from their minute size, I might overlook them with a common lens, I put many of the scales under the microscope, but did not detect more than half a dozen in all; just enough, however, to show that they are not altogether absent. All the phe-

nomena in the case would be satisfactorily explained by the theory that the female Bark-louse, in these instances, had failed to become impregnated. In this case she might perish without forming eggs, or she might go on to the formation and deposition of her ova, since we may infer from analogy, such for example as that of the common fowl, that the presence of the male is not essential to the formation of ova, but only to their fertilization. This theory is so plausible that I can scarcely avoid the conclusion that it affords the true explanation of a part, at least, of these cases; but how large a proportion, if any, is of course wholly a matter of conjecture.

The absence of the Chalcis of the Bark-louse in this locality will furnish an excellent opportunity for testing the practicability of transporting it thither from those places where it is known to exist. If, after taking the necessary preliminary steps, as described in a former part of this article, we should find, next September, upon the trees experimented with, the characteristic holes in the scales which mark the exit of the Chalcis, we should know that the friendly parasite had entered upon its work. If such an experiment could be conducted to a successful issue, it would furnish one of the most admirable instances on record of the triumph of science, in its application to economic entomology.

NOTE UPON THE CLASSIFICATION OF THIS SPECIES.

We have in the more Northern sections of the United States, two species of Bark-louse infesting the apple tree: one a native American species, known as Harris's Bark-louse, which prevails mostly South of the thirty-ninth parallel of latitude, though found in diminishing numbers considerably farther North; the other, supposed to be an imported species, much more injurious than the other, and occupying a more Northern geographical range, often called, by way of emphasis and as indicative of its notorious character, simply the Apple-tree Bark-louse, or more specifically, the Oyster-shell Bark-louse, this name being derived from the shape of the scale. It is the latter species of which we have here been treating.

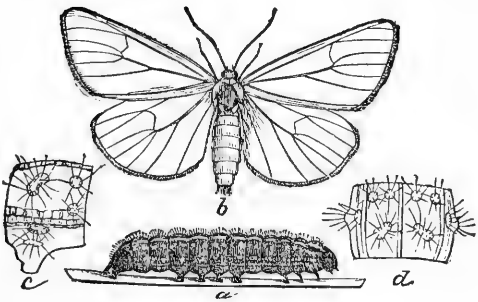
This species has been classed by all our more recent entomological writers, under the genus *Aspidiotus* of Bouché, following the determination of Dr. Fitch, as obtained from Mr. John Curtis, a distinguished English entomologist. In the recent elaborate revision of the family of Coccidæ, by a French author, M. Signoret, the genus *Aspidiotus* is restricted to those species having a rounded form, with the larva scales attached at or near the middie, and a new genus, named *Mytilaspis*, (meaning muscle-shaped shield,) is formed to contain those species which have a long narrow form, usually a little curved to one side, like the shell of a muscle, and having the larval scales attached to the anterior and smaller extremity.

Though opposed, as a general principle, to the disposition exhibited by many modern authors, to the excessive sub-division of genera under distinct sub-generic titles, yet the name *Mytilaspis* is so happily expressive of the form of these insects, that I have thought it best to adopt this term for the present species, and also for that found on the leaf of the pine, treated of at the close of this report.

The specific name, *conchiformis*, was originally given by Gmelin to a European species, the history of which is a good deal confused. It appears to have been originally applied to a species found on the elm; but Dr. Shaw, as quoted by Dr. Harris, states that it is abundant on the apple trees in England, and Mr. Kirby and Mr. Rennie add that it is also found on the currant-bush, all of which, as respects its habit, goes to identify that species with our Northern Apple-tree Bark-louse. Moreover the description given by M. Signoret of the *M. conchiformis*, as found upon the elm, corresponds, in all its more obvious characters at least, to our apple-tree species; but on the other hand it is a remarkable fact, and one which tends to throw considerable doubt upon the identity of the species, that the *M. conchiformis* of Europe seems to be generally admitted as peculiarly the Bark-louse of the elm, whereas our American species, so far at least as I have been able to observe, is never found upon the elm in this country. The force of this fact, however, as affording an argument against the identity of the two species, is considerably weakened by the occurrence of our species on the currant-bush, and very abundantly on the Persian Lilach—plants as far removed as the elm in their natural relations to the apple tree. This question of identity can be definitely settled only by the actual comparison of specimens obtained from these several sources.

But here follows some interesting statements appertaining to this subject. M. Signoret, writing, we may presume, more especially from observations made in the latitude of France, speaks of the *M. conchiformis* as being exclusively an inhabitant of the elm, and described another species, under the name of *M. pomorum* of Bouché, as being the species which infests the apple tree. Upon referring to this description and the figure illustrating it, we find it to be quite different from the species that infests the apple tree in this country. Besides some minute particulars, it is described as having a blackish-brown scale with a white apical border, whereas our species is of a uniform ashen-brown color, like the bark of the tree, and still more remarkable as having red eggs, whilst the eggs of the American *conchiformis* are invariably white. Neither can it be identified with the Harris's Bark-louse of this country, which, though it resembles the other in having red eggs, is of different form and belongs to a different sub-genus. From all this we draw the interesting conclusion that in Europe, as in this country, there are two species of Bark-louse, a more Northern and a more Southern species, which inhabit the apple-tree.

INSECTS INJURIOUS TO THE PEAR-TREE.



The Pear Calimorpha and its larva, of the natural size, with some of the segments of the latter magnified to show the characteristic markings.

THE CALIMORPHA PEAR CATERPILLAR.

(*Callimorphia Lecontei*, Boisd., var. *fulvicosta*, Clemens.)

Order of LEPIDOPTERA. Family of LITHOSIIDÆ.

The only new insect injurious to the pear tree, which has come to my knowledge the past season, by which I mean the only insect that has not been heretofore known and described as a noxious insect, is a blackish hairy caterpillar, an inch and a quarter long, with five narrow yellow and white stripes extending the length of the body, which is the larva of the above named moth.

On the sixth of May I received a box from Mr. E. J. Ayres, of Villa Ridge, at the southern extremity of the State, containing seven of these caterpillars, with the following account of their habits:

"I send you a few specimens of the Solitary Caterpillars, which have been quite troublesome to my pear trees. They appear to be quite general feeders, as I have found them on both cherry and

peach trees, but they appear to be quite partial to pears. I have killed perhaps a thousand of them in my pear orchard this spring. My pear orchard consists of two thousand trees, set two years ago."

In a subsequent letter, dated May 10th, Mr. Ayres makes the following additional statements: "The caterpillars of the kind first sent have all disappeared. I think they must go through their transformations under ground, or else somewhere outside of the orchard; nor do I think that the eggs are laid upon the pear twigs, for I should certainly have found some of them." He goes on to say that he thinks they must pass the winter in the caterpillar state, from the fact that he had seen no very small caterpillars, but that they make their appearance all at once, from one half to fully grown, though he had seen a very few not more than one-quarter grown. He adds that they appear to be very migratory in their habits, and that he had killed a caterpillar nearly every day for a week on the same small tree, one taking the place of another. Of the seven caterpillars sent, one must have been lost, as I have a record of only six. One was put in alcohol and preserved in the larva state; two were taken into Chicago to be delineated and engraved, and died from not being properly supplied with food. The other three were put into a glass covered box and regulerly fed with pear leaves. The box was partly filled with earth, that they might go into it to transform if it were their nature to do so; and some chips were laid upon the earth to which they might attach their cocoons. On the 13th and 14th of the month, that is about a week after I received them, two of them crept under the chips and inclosed themselves in their cocoons, into which little bits of loose earth were woven so that nothing but the earthen particles were visible. The other continued to feed ten days longer, till the 24th of May, when it made its cocoon like the others, of web and particles of earth, attached to the under side of a chip. Two of them, owing probably to the unnatural conditions to which they were subjected, failed to come to maturity. One of them fortunately completed its transformations, which was all that was necessary to determine the species.

The perfect, or winged form of this insect, is a whitish moth with yellow markings; the body three-quarters of an inch long, and the wings expanding two inches. The general color of the body and wings is white, with a satiny lustre, and with a scarcely perceptible yellowish tint. The antennæ are blackish-brown. Palpi yellow tipt with brown. The head, collar, scutellum and first segment of the abdomen are yellow; as are also the

sides of the breast, the legs, and the costa, or anterior border of the wings. The anterior and middle tarsi and the tips of the posterior tarsi are blackish-brown. In some individuals the anterior and middle tibiæ, or shanks, are also blackish-brown on their outer face.

This proves to be a pale, and remarkably distinct variety of a very variable species of moth belonging to the genus *Callimorpha* of Latreille. It has been described and named no less than four times, by different authors, as so many distinct species, in the following order of priority:

Callimorpha Lecontei, Boisduvol.
C. militaris, Harris.
C. fulvicosta, Clemens.
C. vestalis, Packard.

The last variety appears to have been founded upon a pair of small specimens of the preceding one. The descriptions of the two varieties are almost precisely identical. The smaller size and the absence of the blackish tint on the tibiæ and tarsi are insufficient characters to establish a well-marked variety upon, much less a species, especially in so variable an insect as this. In Mr. Walsh's, Mr. Riley's, and my own collections are specimens varying nearly as much in size, and in which the black shade upon the legs is of various degrees of distinctness, and in several of the specimens is wholly wanting.

The other three varieties, however, are so strongly marked, that it is not at all surprising that they have been described as different species. Indeed they never could have been suspected to be the same, were it not that intermediate grades have been discovered which bridge over the space between them. The white variety above described is the *fulvicosta*. In the *militaris* the fore wings are bordered nearly all around with dark brown, a band of the same across the end, and also an angular projection from a little beyond the middle of the costal border. In the *Lecontei* the brown color predominates, so that Dr. Harris describes the fore wing of this variety as being brown, with five large white spots. The hind wings are simply white in all the varieties.

The caterpillar was first described by me and figured in the Prairie Farmer, where it was, by mistake, assigned to the wrong species. I now place it in its true relations. The following description was taken from the specimens sent by Mr. Ayers:

Length one inch and a quarter. It may be described in general terms as a blackish, somewhat bristly caterpillar, with a shining black head, and with three narrow but conspicuous orange stripes extending the length of the body, one dorsal and one on each side; and below the latter a whitish line interrupted by yellow spots. The orange stripes, when closely examined, are found to be made up of little elongate pieces arranged in a linear series. In the middle portion of the dorsal stripe, these pieces have the form of little urns with their mouths directed forward. The lateral stripes are still more irregular or jagged. These stripes are not wholly orange, but interspersed, especially the lateral ones, with white and lemon-yellow. There is also a yellow spot on the outer side of each of the prolegs. The broad portion between the dorsal and lateral stripes is velvety black, divided longitudinally into two parts by an indistinct whitish line with wide interruptions. The body is rather sparsely clothed with short stiff hairs or bristles, black and white intermixed, radiating from little black warts or tubercles, with steel-blue reflections, of which there are twelve on each segment, arranged as follows: Three between the dorsal and lateral stripes, one between the first and second lateral stripes, one below the last stripe, and one at the base of the prolegs. The under side of the body is sordid white sprinkled with blackish.

This is an interesting insect, in a scientific point of view, but it has not multiplied, as yet, to a sufficient extent to make it of much practical importance. Its solitary habits, that is its mode of feeding separately, or not in flocks, would render it a troublesome insect to contend with should it ever become very numerous. The only method that suggests itself to us, at present, of destroying them, is by the common practice of hand-picking, or shaking them from the trees and crushing them under foot.

The following cut, made at the office of the Prairie Farmer, exhibits another view of these caterpillars, both in their natural size and magnified.

INSECTS INJURIOUS TO THE PLUM-TREE.

THE GREEN, CHESTNUT-BACKED PLUM CATERPILLAR.

(*Acronycta superans*, Guenée.)

Order of LEPIDOPTERA. Family of NOCTUIDÆ.

On the 18th of June I discovered upon a plum-tree, and at a distance from each other, two rather thick-bodied green caterpillars, with a broad chestnut stripe along the back, once inch long when extended, but usually a little shorter owing to their habit of humping up the anterior half of the body, whilst the head and posterior part remained upon the same level. When first observed, in the middle of the day, they were not feeding, but resting perfectly motionless. I put them in a box and fed them with plum leaves. During my absence from home one of them escaped. The other crept under a chip lying upon the earth with which the bottom of the box was covered, on the 23d of June, and inclosed itself in a thin cocoon mixed and covered with particles of earth. and attached to the under side of the chip, in a manner very similar to that of the Pear Caterpillars described on a preceding page.

On the first of July I found upon another plum tree, a much smaller, less than half grown individual of the same species, having a small Ichneumonideous cocoon attached crosswise to the under side of its body, just in front of the anal prolegs. The parasitic Ichneumon-fly emerged from this cocoon on the 10th of July.

On the same day, (July 10th,) the first mentioned caterpillar emerged from its cocoon, in the form of a gray and white moth, belonging to the genus *Acronycta*, and very similar to, if not identical with the species named at the head of this article. It is a

very rare moth in this part of the country, and has not before, I believe, been reared from the larva state. There is no specimen of it in the Walsh cabinet, but Mr. Riley has a single specimen, presented to him by Rev. C. J. S. Bethune, of Canada, under the name given above, of *Acronycta superans*, of Gueneé. It would seem to be a more common species farther north, as Mr. Bethune, in his notes on Canadian Lepidoptera, speaks of having captured numerous specimens at Cobourg, in June, 1855. It can scarcely at present be considered a noxious insect. Nevertheless it feeds upon one of our fruit trees, and, from its considerable size and its non-gregarious habits, it might become a serious pest if it should ever become numerous.

In the short account given above of these caterpillars, and which contains all we at present know of them, five circumstances are mentioned which we here repeat, in order to show what important inferences may sometimes be drawn from a few well attested facts. First, they were found upon a plum tree and were afterwards fed to maturity upon plum leaves; they must, therefore, in proportion to their numbers, be injurious to this tree, and must be admitted into the catalogue of noxious insects. Second, from their being found at a distance from each other, we conclude that they are solitary in their habits, and therefore would be more difficult to destroy if they should ever multiply to any serious extent. Third, from their being stationary by day, we infer that, like many, and perhaps most caterpillars, they are night-feeders. Fourth, from the discovery of a much smaller individual later in the season, it is probable that they have two broods in a year; and, fifth, from the attached cocoon of the Ichneumon-fly, it is evident that we shall have the aid of parasitic insects in keeping this species in check. As this is a very rare moth, and as it does not appear to have been reared from the larva state, and moreover as the description of the *superans*, by Gueneé, is incomplete in some of the most characteristic particulars, I herewith subjoin a more detailed description of the insect in both the larva and the winged state:

Larva, or Caterpillar.—Length, one inch. Body thick, green, with a broad, chestnut-brown stripe the whole length of the back, separated from the adjoining parts by a yellow line. Within the stripe, on the top of each segment, are little shining black tubercles, two on the first, second and third segments, and four on the others, arranged in a transverse curved line, each emitting one or more black hairs, but wanting on the last ring. Some long, sparse, whitish hairs along the lower part of the sides.

IMAGO, OR MOTH.—Length between seven and eight-tenths of an inch. Expanse of the wings, one inch and six-tenths. Antennæ setaceous, brown. Labial palpi, a little longer than the head, porrected; basal joint black above, with long white scales beneath; second joint white beneath at base, gray at tip, with a broad, oblique black band across the middle; third joint very small, gray. Maxillary palpi obsolete, appearing only as a minute pencil of white hairs. Proboscis quarter of an inch long, pale brownish; face dark gray, with a small but distinct white spot in center; thorax pale gray or cinereous, collar and tegulæ distinctly dotted with black; abdomen cinereous, indistinctly sprinkled with black points, most obvious near the tip; fore-wings varied with black or brownish black and white. The blackish portion presents, under the lens, and in the fresh specimen a tint of dark metallic green, which seems to be nearly or quite lost in the dried specimen. The coloration of the wing is somewhat equally divided between the white and the dark portions. Regarding the white as the ground color, the black portion may be described as follows: a broad, diffused, irregular vitta or longitudinal band extends the whole length of the wing, nearer the posterior than the costal margin. From the middle of this stripe, a broad, imperfect band extends across to the costa. There are three series of blackish spots across the end of the wing, two of which are approximate, and sub-terminal; the other, further inwards, less perfect, but presenting in its middle a larger, somewhat triangular blackish spot; the costal margin is divided into alternate portions of black and white. At the posterior basal angle of the wing is a pale, but distinct oblong buff-colored spot. Posterior wings cinereous brown, with a central lunule, a middle, transverse line, and the terminal border of a deeper color; their under side whitish, with the same lunules and lines and a series of terminal brown points, very distinct; legs black, annulated with white.

The characters of the posterior wings are here copied almost verbatim from Guencé, and serve more distinctly than any other part of his description to identify the species with the *superans.*

If this should prove to be a distinct and undescribed species, I propose for it the name of *Acronycta prunivora.*

INSECTS INJURIOUS TO THE GRAPE-VINE.

THE AMERICAN VINE-CHAFER.

(*Anomala lucicola*, Fabr.)

Order of COLEOPTERA. Family of MELOLONTHIDÆ.

One of the insects injurious to the grape vine in Europe, and sometimes to a serious extent, is a small beetle belonging to the family of Melolonthidæ, and resembling, in its general characters, the common May-beetle or Dorr-beetle which makes such a buzzing about our lamps in the early summer evening. This insect is known as the *Anomala vitis*, or Vine-chafer, and we have in this country one species at least, of the same genus, which has the same injurious habits, though never to so great an extent. This species is now generally regarded by entomologists, I believe, as the *Anomala lucicola* of Fabricius, though it has often been confounded with another species, the *A. varians* of the same author. Dr. Harris mentions it in his treatise upon the noxious insects of Massachusetts, and speaks of its being quite destructive in particular localities of that State in the year 1825.

About the last of June of the present year (1870), I received a box of these insects from Mr. E. J. Ayres, of Villa Ridge, to whom I have been indebted for many interesting insects, and to whom I am happy to have this opportunity of publicly expressing my thanks. Mr. Ayres gives so graphic an account of the habits of this insect, as observed by himself, that I cannot do better than copy his words:

"I send you a box of perhaps a dozen or more beetles which are new to me, and which are just now making sad havoc with

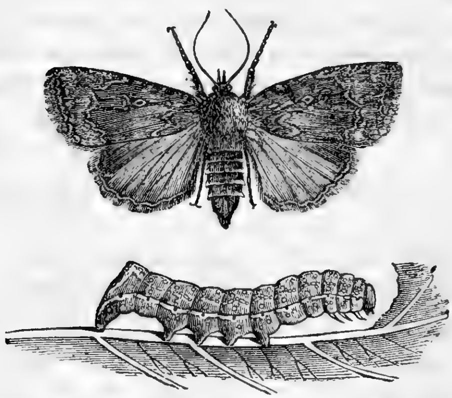
our Norton's Virginia grape-vines, eating the leaves in a manner similar to the leaf inclosed. The first I noticed them was about four days ago, when, about sun-down, in my pear orchard, they were flying close to the ground, in a ziz-zag style, as if they were hunting for something, and were in such numbers as to sound like a swarm of bees. After I had eaten my supper, and it had become quite dark, I discovered them in great numbers on the Norton's Virginia vines. They would shake off very easy, and 'play possum' for a few minutes, and then fly up and commence again. The next morning I went out to sprinkle the vines with lime, and to my surprise, found there was not a beetle on the vines; all were gone; but of two hundred and fifty vines they had eaten half of the leaves. In searching, I found large numbers in the ground, under the vines, but apparently not in so great numbers as they were on the vines the night before. This was Friday morning. I was obliged to go to Cairo on business, and did not get back till Sunday, and on my return found that the vines did not look as if they had been injured any during my absence, or at least but very little. I took a look to-day and found them still in the ground, about half an inch deep, and generally in pairs. In my vineyard of twenty varieties, they have disturbed none but Norton's Virginia. In a neighboring vineyard containing say a dozen Norton's, with several thousand Concords and Ives, they have eaten all the Norton's, and worked a little upon some adjoining Concords, but they were evidently not suited to their taste. Judge Brown, who has but three or four Norton vines, in a vineyard of three or four hundred vines of different kinds, finds his Nortons badly eaten and none of the others touched. I shall examine the vines to-night, and if possible ascertain if they come out of the ground and eat the vines. They do not eat at all in the day time."

Dr. Harris speaks of the Anomalæ as being diurnal in their habits, and the specific name of *lucicola* given to this species by Fabricius, if indeed it be the same, means loving or seeking the light. But from Mr. Ayres's observations, it appears that, like many of our larger Melolonthians, this is a night-feeding species. Mr. Ayres's description of its mode of flight calls to our mind the low, mousing flight of another and more common, allied species,

the Cetonia Inda, very much like that of a hawk, scouring over a field in search of mice.

The leaves eaten by these insects resemble a piece of coarse, irregular net-work, all the larger veins and part of the smaller ones being left.

From the great numbers and concerted operations of these insects, and the suddenness with which they make their attack, it is evident that serious loss might be suffered from them before their depredations were discovered. The ease with which they are shaken from the vines suggests the method of capturing them, by shaking them onto a sheet; but their nocturnal habits would render this inconvenient if not impracticable. Dusting the leaves with lime, as above suggested, or if this did not succeed, syringing them with tobacco water or whale oil soap, might prevent their depredations.



THE GREEN, CREAM-SPOTTED GRAPE-WORM.

(*Amphipyra pyramidoides*, Guenée.)

Order of LEPIDOPTERA. Family of NOCTUIDÆ.

I have heard of the larva of this insect from various localities in the southern half of the State, but little has yet been recorded concerning its numbers or its habits. The Caterpillar is a fleshy, green, naked worm, about an inch and a quarter long when fully

grown, sprinkled with minute cream-colored or straw-colored spots. There is a cream-colored line along the back, and a yellow line along the sides, connecting the spiracles, or breathing pores, which appear like black points, each one being surrounded by a narrow white ring. The perfect insect is a dark brown or blackish moth, varied with rather obscure whitish spots and zigzag lines. The hind wings are dark coppery-red, with a dusky border. The larva is figured in the American Entomologist, Vol. I., page 225, and the moth in Vol. II., p. 26.

I received some of these Caterpillars from Mr. E. J. Ayers, of Villa Ridge, early in May, with the following note: "The green worms with cream-colored spots, I find on my grape vines. They are not numerous, but they are ravenous feeders. Should they become numerous they would be very destructive." At the time of their reception the leaves of my cultivated grape vines were but just opening, and I fed them on the leaves of the wild grape vine which was running over my garden fence and which was more advanced. They are, as Mr. Ayers remarks, gross feeders, and are very easily reared. Some caterpillars are very restless in confinement, but these creatures strongly remind me of a hog, being perfectly contented so long as they had enough to eat. Sometimes, after eating their fill, they would roll over upon their sides and take a rest, very much like the gluttonous animal just referred to.

They began to transform on the 16th of May, folding a piece of grape leaf pretty close around their bodies, and lining the cavity very slightly with silk. Different individuals remained in the chrysalis state from forty-two to forty-eight days. The character of the moth is strongly contrasted with that of the larva with respect to its activity. The caterpillar, as we have just stated, is gluttonous and sluggish in its habits. The moth, on the contrary, is extremely alert, and rapid in its motions, lying in an abrupt, zigzag manner. I came very near losing some of my specimens, though they were within the walls of my office. One of them flew precipitately across the room, dove in amongst the books in one of my cases, and concealed itself so artfully and pertinaciously, that though I saw where it flew, I had to take down upwards of an hundred volumes before I could discover it.

This insect has also been bred by Mr. Riley, of St. Louis, and

by Major Muhleman, of Woodburn, Ill. The former states that he has found the same caterpillar on the Red Bud and the Poplar. They have not as yet been known to multiply so but that they could be easily destroyed by picking or knocking them from the vines.

INSECTS INJURIOUS TO THE CURRANT.

THE SPINOUS CURRANT-CATERPILLAR.

(*Vanessa* (*Grapta*) *Progne*, Fabr.)

Order of LEPIDOPTERA. Family of NYMPHALIDÆ.

Fitch's Third New York Rep., No. 142.

A light-brownish or drab colored caterpillar, about one inch in length, thickly beset with white, branching spines, slightly tipped with black, and averaging in length about half the width of the body. The face also is prickly with short, whitish spines. The first segment or collar is narrower than the head and second segment, forming a neck between the head and body. Pupa suspended with the head downward, often attached to a twig or leaf stalk; pale brown, faintly clouded upon the side with olive-green, and the abdomen broadly striped, with the same on the back and sides. There is a deep depression across the middle of the back, on each side of which are two small silvery spots.

In its perfect state this insect is one of our most common and widely disseminated butterflies, being met with over nearly the whole of the North American continent. It expands from one and three-quarters to two inches. It has scalloped wings, of a bright tawny or orange-red color, with black spots. On the under side the wings are entirely different, being of a blackish-gray color, paler at the tips, and with a small silvery mark on the hind wings, resembling the letter L.

The larva or caterpillar of this species sometimes feeds upon the leaves of the currant, but from the fact that the butterfly is common, whilst its larva is not generally known as a currant-eating caterpillar, it is evident that it must, ordinarily, have some other

kind of plant food. Dr. Harris speaks of having raised it from caterpillars found feeding upon the elm, but makes no mention of its eating the currant. Dr. Fitch, in his New York Reports, speaks of them as sometimes eating the leaves of the currant, and on the 15th of July I received a number of these caterpillars from Mr. B. N. McKinstry, of Judson, Kankakee county, accompanied with the statement that they were doing considerable mischief by stripping the leaves from his currant bushes. This is, I believe, the first record of its feeding upon the currant in this State, and it cannot be regarded, at present, as a noxious insect of a serious character.

I made a few observations upon the individuals sent to me, of some scientific interest, which I will briefly state.

The chrysalis state, which is stated by Drs. Harris and Fitch to vary from eleven to sixteen days, lasted, in my speimens, only seven days. The weather was excessively hot, the thermometer indicating, most of the time, 100 degrees, which may, perhaps, account for the rapid development.

As these caterpillars, after they had suspended themselves for the purpose of transformation, hung directly in front of my study table, I was led to observe more closely than I had hitherto done, the process by which these creatures divest themselves of their larval covering. It appears to consist of two stages: the first is slow, gradual and almost imperceptible, occupying some twenty-four hours of time, during which, it may be presumed, there is effected a gradual separation of the larval from the pupal envelope. During this period the caterpillar hangs with its body curved forwards and upwards, and appears to be almost motionless; but upon close observation it is seen to undergo almost continuous though slight changes, consisting of a nodding motion of the head, and an occasional variation in the curvature of the body. The second stage is short and active, usually lasting but a few minutes, the object of which is to throw off the loosened larval skin; first, by bending the body it bursts open the skin upon the back, and then, by a wriggling motion, works it up towards the point of attachment, and lastly detaches and throws it entirely off by a series of violent contortions, apparently at the imminent risk of severing the thread upon which its safety literally depends.

Should this insect ever become numerous in any locality, it would have to be destroyed in some of the ways commonly resorted to for caterpillars of this kind, namely: by shaking them from the bushes and crushing them under foot, or dusting the leaves with ashes or lime.

THE FOUR-STRIPED PLANT-BUG.

(*Capsus* (*Phytocoris*) *quadrivittatus*, Say.)

Order of HETEROPTERA. Family of Capsidæ.

Upon going into my garden on the morning of the seventh of June, my attention was arrested by the blighted appearance of the leaves on some of the currant bushes. Upon examining them they were found to be more or less densely sprinkled with little, dried, somewhat square or angulated spots, not much larger than pin heads. Some of the leaves were completely withered, and a number of parsnips which had been left for seed, were found still more severely affected, some whole branches and their leaves being as dead and brown as if they had been severed from the plant for a week. I examined the plants carefully, but could find no adequate cause for the mischief, and I was inclined to think that it was either some kind of blight, or that if any insects had been damaging them, they had run their course and disappeared. I saw on most of the bushes a small number of the pretty, black and yellow hemipterous insect whose name is placed at the head of this article, but they did not seem to be in sufficient numbers to account for the evil. I observed them, however, puncturing the leaves, and upon referring to the American Entomologist, I found on page 246 of the first volume, a notice of these same insects having been sent to the editor by Mr. M. B. Bateman, of Painesville, Ohio, with the statement that they were found to be quite injurious to the currant bushes and various kinds of shrubs.

This is an interesting insect, by adding another to the comparatively small list of noxious insects belonging to the order of Heteroptera. This list includes the Chinch-bug (*Micropus leucopterus*), the brown Squash-bug (*Coreus tristis*), the large grey

Plant-bug (*Brochimena annulata*), and the Lined Plant-bug (*Capsus linearis*). The last species, also known as the Tarnished Plant-bug, is one of our most pernicious insects, and belongs not only to the same order, but also to the same genus with the species now under consideration. All these insects do their damage by puncturing the leaves or stems of plants, and wilting them by the abstraction of their sap. The suddenness with which the parts beyond their punctures, wither, and sometimes turn black, has led to the general belief that they infuse a poison into the wounds; but no such poisonous secretion has been proved to exist.

This species has never been fully described, and I therefore append the following description:

Length, three-tenths of an inch. Deep honey-yellow, inclining to orange. Elytra, bright greenish-yellow, with four black stripes.

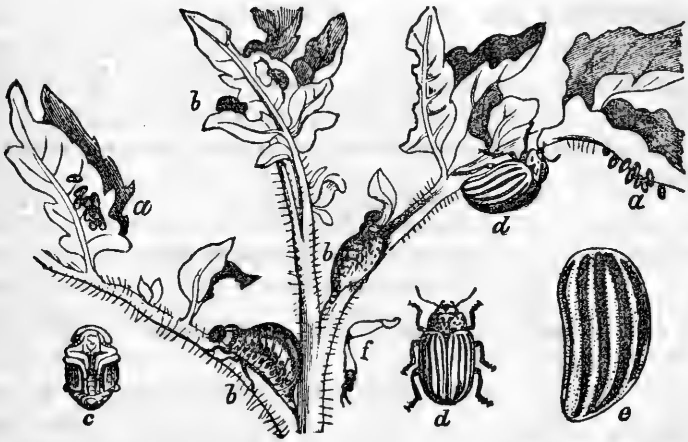
Head, deep honey-yellow; nasus and antennæ, black. Thorax, greenish-yellow; its anterior border, honey-yellow, and with four black stripes; the two middle ones in the form of large sub-triangular spots, the outer ones slender and near the margin. Scutellum, greenish-yellow, with the lateral angles black. Elytra, greenish-yellow, each with two black stripes, the outer ones more slender, near the margin, and having a black dot beyond its tip. Membrane, black. Beneath, honey-yellow, the venter deepening into orange; vent black, in the male furnished wiih two black hooks; in the female with a blackish sword-shaped ovipositor, originating from the middle of the sixth segment, lying upon the venter, when not in use, and concealed between two valvular folds, forming a carina, with its point backwards. When elevated from its sheath, it appears to issue from the middle of the venter. Legs pale-greenish, with two black rings near the end of the thighs; last joint of the feet black.

The females are easily distinguished, at this season, by their more swollen abdomens. Upon opening them they are found to contain about 20 (from 15 to 24) oblong subcylindrical flask-shaped eggs, pale, with white tips. I have not been able to discover where these eggs are deposited.

These insects may be called social rather than gregarious, being sometimes found singly, but usually in small companies.

The insects of the genus *Capsus* are very active, and instantly take to flight when alarmed, especially in the heat of the day. The only time when they can be captured and destroyed is very early in the morning, when they are chilled by the coolness of the night, and therefore disinclined to fly. They can be shaken or brushed off into a pan or pail partly filled with lye or strong suds. Simple water answers just as well, so far as to prevent their flying away.

INSECTS INJURIOUS TO THE POTATO.



Explanation of figures.—a, a, eggs; b, b, larvæ; c, pupa; d, beetle of the natural size; e, wing-case magnified; f, leg magnified.

THE COLORADO POTATO BEETLE.

(*Doryphora*, 10-*lineata*, Say.)

Order of COLEOPTERA. Family of CHRYSOMELIDÆ.

Walsh's and Shimer's articles in the Practical Entomologist, vols. 1 and 2; Riley's 1st Missouri Report, page 101.

This insect does not need to be described. We all know the creature, alas! too well. Though one of our most recent acquisitions in the line of practical entomology, having been known in this State only for a period of six years, yet it is so unceremonious in its visitations, and so free and easy in its manners, after it has arrived, that we have already come to regard it as an old acquaintance. As such we have everywhere extended to it a warm recep-

tion, devoting whole fields of our most valuable esculent to its uses—at least, it has not hesitated to appropriate them thus—and adorning it with our most brilliant pigments. But having, in accordance with the old adage, "Welcomed the coming," we are now quite willing to "speed the parting guest." To tell the plain truth, our visitors from Colorado, with their enormous families, have got to be an intolerable bore. In no former years have the complaints of their depredations been so loud and so universal; the hot and dry summer having evidently been favorable to their multiplication.

I have heard of a few localities, both in Iowa and Illinois, where these insects were numerous last year, but have nearly or quite disappeared this year, giving us a gleam of hope for the future. But such cases, the past season, I believe to have been rare and exceptional, and we have reason to be not a little suspicious that our visitors from the Rocky Mountain country will prove to belong to that class of friends alluded to by the poet in the following stanza:

> "I do not tremble when I meet
> The stoutest of my foes;
> But Heaven defend my from the friend
> Who comes—but never goes."

In our dilemma, the question then is, what can we do to expedite their departure?

In the first place mother Nature has come to our relief, to a certain extent, and has sent a host of assistants to aid us in the task. We can now enumerate at least nineteen different kinds of insects which prey upon the Colorado Potato-beetle. We give their names below, numbering for the purpose of reference:

COLEOPTERA.

1. Tetracha virginica.
2. Calosoma calidum.
3. Harpalus caliginosus.
4. Pasimachus elongatus.
5. Philonthus, sp. undetermined.
6. Lebia grandis.
7. Lytta vittata.
8. Lytta cinerea.
9. Hippodamia maculata.
10. Hippodamia, 13-punctata.
11. Hippodamia convergens.
12. Coccinella, 9-notata.

HEMIPTERA

13. Reduvius raptatorius.
14. Harpactor cinctus.
15. Arma spinosa.
16. Stiretrus fimbriatus.

DIPTERA.

17. Promachus apivorus.
18. Lydella Doryphoræ.

ARACHINDA.—19. Phalangium.

Of these insects, the first five are ground beetles, and are predaceous both in the larva and perfect states, and they devour the Potato-beetles and their larvæ, mostly on the ground or whilst undergoing their transformation beneath the surface.

The next three attack them on the vines.

The next four belong to the family of Lady-bugs and help to destroy the Potato-bugs by eating their eggs.

The four Hemipterous insects are all predacious. They attack the Potato-bugs wherever they can find them and kill them by puncturing them with their beaks and extracting their juices.

No. 17 is a large, savage two-winged fly, which, it would seem, attacks almost any insect that comes in its way. Its specific name means bee-eating, and it is the same insect which has been called the Nebraska Bee-killer. It also kills Horse-flies, and now it is proved to add the Potato-beetle to its indiscriminate bill of fare. I received a pair of these insects from Mr. A. R. Whitney, of Franklin Grove, who caught them in the act of seizing and carrying off the mature beetles. These ferocious insects resemble the hawk in their mode of dealing with their prey. They seize it, fly off with it for a short distance and then alight and devour it at their leisure. Whilst so engaged they allow themselves to be approached quite nearly, and are easily captured. Mr. Whitney followed a number of them, and got possession of the beetles, which he always found dead by the time he could reach them.

No. 18 is a parasitic fly, belonging to the family of *Tachinidæ*, the larvæ of which live in the bodies of the Potato-bugs, and thus destroy them. It was actually bred by Mr. Riley from the infested insects, and I have several times seen this fly or another similar species alight upon the vines in the midst of the beetles and their larvæ.

No. 19 is commonly known as the Daddy-Long legs, and I place it in the list of Colorado Potato-bug destroyers on the authority of Mr. Arthur Bryant, as given in the Transactions of the Illinois Horticultural Society, Vol. I, page 102. To this list may be added, though with some doubt, the Little-lined, or Tarnish Plant-bug (*Capsus linearis*). Early in the season, I received a letter from Mr. James Taylor, of Somonauk, in which, amongst other matters, he spoke of a small insect which pierced with its beak and destroyed the eggs of the Colorado Potato-beetle. As I could not

from his description, identify the insect with any known depredator upon the Potato-bug. I wrote to him requesting him to send me specimens, and soon after received from him a number of the above named species. As the *Capsidæ* are all vegetable feeders, and as the *Capsus linearis* is often abundant on early potato vines, which they injure by puncturing the young shoots, I at first thought that Mr. Taylor had confounded this species with the *Arma spinosa* or some other species which is well known to destroy the eggs of the Potato-beetle in the way he describes. But as he speaks as if he had actually seen them performing this act, and as the *Capsus linearis* is a very indiscriminate feeder as respects its plant-food, and finally as the two *Lyttæ*, above mentioned (Nos. 6 and 7), are also plant-feeders, and yet are admitted, on what is supposed to be sufficient authority, to be occasional feeders upon the larvæ of the Potato-beetle, I am inclined to believe that, after all, Mr. Taylor's observations may have been correct. This point, however, will have to be settled by future observation.

To these insect depredators upon the Potato-bug I have pretty good reason to add a four-footed animal, which we are not in the habit of regarding in a very friendly light, and that is the Skunk. This animal is well known to relieve the opprobrium which usually attaches to his name, by destroying the May-beetle, and its larva the White grub, and some other of the larger sized insects. Whilst on a visit to Benton Harbor, Mich., early last spring, Mr. L. Camfield stated to me that a part of his potato field furthest from the house was comparatively free from Potato-bugs, and that he knew that skunks frequented it from the fact that his dog was often heard barking there, and bore unmistakable evidence, on his return, of the company he had been in. I told Mr. Camfield that as every fact of this kind was of interest, I wished he would watch, some moon-light night, and see if he could verify his supposition. Later in the season, in answer to a letter of inquiry from me, I received a reply from Mr. Camfield, under date of Aug. 15, saying that he had not seen a skunk about his premises, they having been probably frightened away by the dog. But he adds that his brother and neighbor, who have potato patches in the same inclosure, near a thicket much frequented by skunks, have been but little troubled by Potato-bugs, though others in

that section have suffered serious damage. That the Skunk should eat Potato-bugs has no intrinsic improbability, and I think every one must be impressed with a feeling of the extreme appropriateness of the diet.

The testimony with respect to these insects being eaten by domestic fowls is contradictory. The truth seems to be that some chickens will eat them and others•will not, or that they will eat them under some circumstances, such as the pressure of extreme hunger. My next door neighbor, Mr. Wurts, says he has taught his fowls to eat the bugs by throwing them down to them like so much corn, when they were hungry; and he thinks that if all chickens do not eat them it is because their education has been neglected.

The question will naturally be asked, why, with all these enemies, do the Potato-bugs continue to multiply, like the locusts of Egypt? The best answer I can give is, that no one of these many enemies, if we except, perhaps, the parasitic Lydella, is exclusively appropriated to these insects, like the Tachina of the Tussock-moth or the Chalcis of the Bark-louse, mentioned in the earlier part of this report. In other words these various enemies depredate upon the Potato-bugs when they happen to come in their way, but do not depend upon them for subsistence. Besides, the predaceous insects above enumerated do not belong to the prolific class, and therefore are too few in individuals to make much headway againt such a multitudinous host as the Colorado Potato bugs. I have repeatedly walked through potato fields swarming with bugs, with the express intention of taking note of their destroyers, without seeing any creature seriously deserving of the name.

Nature, if left to her own resources, often exhibits wonderful curative and recuperative powers, which are ordinarily sufficient to preserve the balance between the world of insects and that of plants. If in any case, like the present, she seems to fail, it is because we have abruptly disturbed the balance by supplying these prolific insects with a superabundance of congenial food. And now that we are overrun by them we stand aghast at the consequences. But nature often accommodates her economy to human wants, and rectifies our errors and our follies. And I have no doubt that the Colorado Potato-beetle, like other nox-

ious insects that have been equally prevalent, will in time disappear, especially in those localities where it is now most abundant, even though we leave the work wholly to Nature. But we must give her time. Nature moves more slowly but more surely than man, and her judgments take the course of an inevitable retribution. If we can have more patience, and get along with fewer potatoes for a year or two, I doubt not the day of our redemption will draw nigh. But as we do not know exactly when that time will come, and as patience without potatoes may seem to many a tedious virtue, I opine there can be no sin in our doing what we can to hasten the wished-for result. Let us see, then, what hope we can derive from any success that has attended past efforts in this direction.

There are four principal methods and agencies which have been adopted for the purpose of destroying these prolific and pernicious insects: first, hand picking and mechanical contrivances; second, sun-burning; third, starvation; and fourth, Paris-green. Mr. S. S. Barnes, of Olena, Henderson county, says he has preserved his potatoes for the last five years, by mashing between his thumb and finger, every bug that made its appearance on his vines, and picking off their eggs. He says that for early kinds, twice going over, once when the vines are three or four inches high, and again in ten or twelve days afterwards, is all that is necessary. This may be styled the *experimentum crucis* method, and is of course a sure cure, where it can be applied; that is where the field is not too large, nor the bugs too numerous, nor the operator too sensitive.

Speaking of mashing these insects in the hand, suggests the question of their alleged poisonous nature. Mr. Barnes says that though he has practiced this method freely for five years, he has never experienced any poisonous effects from it. There is no doubt, however, that they are poisonous to a certain extent, and this has been most strikingly manifested in the effects of the fumes arising from their burning bodies. Major W. N. Davis, of Aux Sable Grove, recently told me that his neighbors, the Messrs. Cherry, were quite severely poisoned by the smoke arising from an ignited hollow stump into which a quantity of Potato-bugs had been thrown. It affected them very much like an attack of ery-

sipelas, their faces being so much swollen as almost to close their eyes. There are also several cases on record of severe inflammation of the hand and arm, after handling these insects, when there was an abrasion of the skin.

But it is not necessary to touch the insects with the hand. The common practice is to knock them off into a pan or pail. As simple and convenient a plan as I have heard of was adopted by one of my neighbors, Mr. H. C. Hawkins. He took an old meal bag, cut it off in the middle so that it might not be inconveniently long, and fitted into it a small hoop so as to keep the mouth open, and then, passing along the rows, knocked the bugs into the bag with the flat side of a shingle, occasionally shaking the insects down to the bottom of the bag, from which they could not easily escape.

It is not my intention to enumerate the hundred and one mechanical contrivances that have been resorted to for the purpose of killing these insects. I only mention a few that seem to me most worthy of imitation. Mr. J. W. Clark, of Twin Hills, Wisconsin, makes use of the following wholesale method, in field culture. A person with a common broom held perpendicularly with one hand and grasped as low down as convenient with the other, passes along close to or astride a row of the vines, and with a quick lateral motion strkes the vines first on one side and then on the other, scattering the bugs into the spaces between the rows. Another hand follows immediately after with a plow and crushes or buries the greater proportion of the insects. If the potatoes have been already plowed and hilled np, he drags along the furrow a heavy bundle of brush, or a small harrow made for the purpose. A considerable proportion of the insects will of course escape, but the operation is so rapidly performed that it can be repeated as often as necessary. Mr. C. closes by saying: " On the whole, we confidently offer this system of treatment as one that will be found cheap, rapid and effective. The work can be performed in half the time that it requires to apply Paris-green, which, moreover, is not a fit thing for children to handle. The only cost is labor, and this not difficult. A smart boy or girl will easily broom over an acre in two hours."

The second of the methods above enumerated is sun-burning.

If these insects are knocked off the vines in the middle of a very hot and dry day, the mercury in the thermometer ranging at 95° or upward, they will die in about one minute, as I have tested by actual experiment. The soft-bodied larvæ roll over and over and seem to almost liquify from the heat. The beetles spread their wings and attempt to escape, but cannot rise from the broiling surface. Two of my fellow travelers on the *ad interim* Committee, Mr. Galusha and Mr. Wier, both certify, from their own experience, to the efficacy of this method when the conditions are favorable. The former adds that it is most effective where the potatoes have been hilled up, so as to present an inclined plane of crumbling earth, up which the insects must climb, under the fierce fire of the enemy, before they can reach the protecting shelter of the over-spreading foliage. The objection to the practice of this plan is that the operator has to expose himself to the same heat which is fatal to the insects, and besides, there are usually but few days in the year when this remedy is available.

Another agency for lessening the numbers of the Potato-beetle is starvation. This takes place from the simple fact that the insects, in some cases, eat all the potatoes and other available food within their reach, whilst many of them are immature, and before the season is far enough advanced for them to go into winter quarters. I have been forcibly struck the present season with the efficacy of this condition of things in my own neighborhood, and it must have occurred in many other localities. I have seen myriads of these insects, in all their stages, leaving the potato-fields, where they had left scarcely a stump standing, and traveling over fences, buildings and roads, and I may say everywhere, but where there was no congenial plant food within their reach. The perfect insect, it is true, can fly to a considerable distance, but the supply of food sometimes gives out when the great majority of the insects are in their larva state. I have heard of their being seen crawling half a mile or more from any place where potatoes grew: this, however, I think must have referred to the mature beetles, which had availed themselves of their wings for a part of the distance. An important question arises in such cases, whether these insects are capable of subsisting upon other plants besides the potato, to a sufficient extent to preserve them from starvation. It is

a curious fact that these ravenous insects seem to be exclusively appropriated to the natural family of *Solanaceæ* or the Night-shade family, upon all the species of which they will feed to some extent.

This family includes, in addition to the Potato, the Tomato the Egg-plant, the Bitter-sweet, the Black Night-shade, the Horse-nettle, the Ground-cherry, the Thorn-apple, the Henbane, the Tobacco, wild and cultivated, the Box-thorn, and the Cayenne Pepper. Upon two of these plants, the Egg-plant and the Horse-nettle, these insects feed as readily as they do upon the potato, but upon all or most of the others they eat sparingly and only from necessity. We sometimes hear of them eating other plants, and I have seen the Thistle and other plants slightly gnawed by them when on their march for more congenial food, but it is only as an act of desperation. The Thorn-apple, or Apple of Peru, they will eat more freely, but they do not like it; and the Cayenne Pepper, if eaten to any considerable extent, is fatal to them. Mr. Ellsworth, jr., of the Naperville nursery, informed me that he had several times found the bugs lying dead under the pepper plants upon which they had been feeding. Now it is evident that all the plants above enumerated are too rare in locality, and too small in quantity to afford subsistence, to any considerable extent, to such a prolific and multitudinous species as the Colorado Potato-beetle; and there can be no doubt that in such a season as the present, in many localities, millions of these insects must have perished for want of food. And though there will probably be enough left to continue the breed, yet they will be so much reduced in numbers that their presence will hardly be noticed for years to come. And, besides, in proportion, as their numbers are reduced, they will become subject to the depredations of predaceous and parasitic foes.

In such ways as these does Nature come to our relief from the indefinite encroachment of the many noxious insects to whose depredations we are exposed, and says to the advancing tide, with more authority than did Canute, of old: "Thus far shalt thou come, and no farther."

I think there is no doubt that we could avail ourselves of the starvation process to exterminate the Colorado Potato beetle, if this insect should prove to be of a sufficiently persistent character

to induce a concert of action amongst agriculturists. This could be accomplished by planting only the earliest varieties of potatoes. If this method were universally put in practice, there would be no potatoes after mid-summer for the insects to feed upon, and they would probably all perish from starvation. And even if a small proportion of them should subsist upon other plants till fall, they would be of too old a brood to survive the winter and perpetuate the race another year.

But it is now generally admitted that the most effective remedy for the Colorado Potato-beetle, so far as human agency is concerned, is the application to the vines of the poisonous substance commonly known as Paris-green, and chemically designated as the Arsenite of Copper. This substance proves fatal to the insects, not by coming in contact with them, but by being eaten by them. Indeed, these creatures have a very pertinacious vitality under all the ordinary applications which prove destructive to insects. I have thoroughly sprinkled the infested vines with copperas water, one ounce to the quart, which has been highly recommended; and with fish brine, one quart to two gallons of water, but both applications hurt the vines much more than they did the insects. I have also immersed the beetles in diluted carbolic acid, and then rolled them over and over in Paris-green, and put them in a box, and some of them were alive on the next day. But when this article is eaten by them with the foliage, it proves speedily and certainly fatal.

The first time that I knew of this substance being used on a large scale, was in the summer of 1869, by Mr. E. W. Grosvenor, of Hastings, Minnesota. This gentleman used twelve dollars worth of Paris-green, diluted at about the rate of one quarter of a pound to half a peck of flour, and saved his potato crop. Upon the older vines it had to be repeated, but upon vines three or four inches high, he thought it affected them in some way which rendered them thenceforward repugnant to the insects. But upon this point it is proper to remark that the testimony is conflicting. Mr. Grosvenor also mentioned the interesting incident that in stripping the bark from some old fence posts in the winter time, near the fields that had been infested by the bugs, he found thousands of them, which had availed themselves of this shelter for the winter,

though it is generally supposed that the majority of them hybernate under ground.

To show the efficacy of Paris-green on a large scale and in energetic hands, I cannot do better than to quote, in full, two letters which I have recently received, relating to this subject, and from two very remote localities:

BIG THOMPSON, COLORADO, *Oct.* 7, 1870.

DR. WILLIAM LEBARON:

Dear Sir—In the Prairie Farmer of May 28, you requested a report from those who experimented with Paris-green. Here is mine:

The Colorado Potato-bug attacked my potato field early in May, and having a large crop (twenty-five acres), I procured nine pounds of Paris-green and mixed it with six times its bulk in flour, and applied it to the vines in the morning, when the dew was on. The result was, I killed millions of bugs and saved my potato crop.

I commenced digging my potatoes on the 10th ult., and have now about eighteen hundred bushels in the pits, and expect to have about three thousand bushels in all. The second brood of bugs have made their appearance, and the ground is literally covered with them; thousands of them crawl into the potato pits and eat the potatoes voraciously, especially the cut ones. I found as many as twenty-five bugs on one potato. Will they live in these pits all winter? If so, I fear that they will damage the potatoes to a great extent. Is their any remedy that will exterminate them now?

Very respectfully, your obedient servant,

JOHN SULLIVAN.

In reply to this letter, I stated that if Mr. S. thought it too early in the season to close his pits with earth, I should advise him to cover them with a close matting of straw, which would be likely to exclude most of the insects, and yet give sufficient ventilation; and as to their damage in the pits, I thought it would be of short duration, as approaching winter would render them torpid, and in the spring their tendency would be to leave the pits in search of light and fresh food, and in obedience to the instinct of propagation.

RUSHVILLE, INDIANA, *Sept.* 26, 1870.

DR. WILLIAM LEBARON:

Sir—Having seen, by chance, a number of the Prairie Farmer, of Sept. 10, containing a few remarks by you in reference to the Colorado Potato-bug, I send you my experience and observations. The first ever seen in this locality made their appearance in June, 1869. Paris-green, mixed with five to ten parts of wood ashes, effectually destroyed them, and the crops of potatoes were unsurpassed. Last Spring they came much earlier in the season, very soon after the potato tops were above ground, and by millions. Paris-green, used in the same way, was entirely effectual; but a second brood appeared, which was destroyed in the same way, and potatoes are good for this season. Variety, mostly Early Rose. Many of my neighbors used Paris-green in the same way with similar re-

sults. Have not known it fail in a single instance; and have not heard of a single case of any evil result from using the poison. All were informed that it was poisonous, and to be used with care.

Why not form a line North and South from Lakes to Gulf of Mexico, at a point East of where they have thus far been found, and the farmers on that line organize and poison them out as they come, and prevent their migration eastward? Every farmer east of the line is interested and should aid.

Respectfully,

GEORGE C. CLARK.

It is refreshing to read such letters as these, written with a clear head and a strong hand, and which give us faith to believe that the Colorado Potato-beetle, like most other ills that afflict humanity, can be mitigated, if not wholly overcome, by energy and perseverance.

With regard to Mr. Clark's suggestion of a cordon of Paris-green across the continent, I replied to him that I thought it a very excellent one, with one slight drawback, and that was that it would be impossible to carry it out. Farmers are never guilty of such concerted, beneficent action. If they were, the worst pests that afflict them, the Potato-bug, the Curculio and the Codling-moth would, before this, have been practically exterminated. But farmers are like other people; some are ignorant, some are shiftless, some are timid, and some have other and greater interests at stake to distract their attention; and the result will be that gaps enough will be left, through which the advancing hosts will march on to their allotted destination. My friend, Prof. Welch, told me that when he made his visit to his old homestead in Maine, last summer, he took a box of the Potato-beetles with him, and the circumstance becoming known on his arrival, the liveliest curiosity was excited to see the notorious strangers, and that some people traveled fifteen miles to get a sight of them.

Have patience, friends, and in due time, in all probability, your utmost curiosity will be gratified. This Western tortoise in miniature is plodding on his way to you-ward, at the rate of fifty or sixty miles a year, and, in good time, he will meet you at your threshold and will say to you, "Lo! I am here. I have come a long and weary journey, I have crossed high hills, broad lakes and rushing rivers, enemies have waylaid me on every side, and manifold perils have beset my path; but I have overcome all obstacles, and have arrived at last, and shall abide with you for a sea-

son; and to see me you will henceforth need to make no distant pilgrimage."

Here is a letter upon the other side of this question:

SALINA, KANSAS.

DR. W. LEBARON:

Dear Sir—Some time since you requested a report from those who experimented with Paris-green. Here is mine:

The Colorado Potato-bug attacked my potato patch. I dusted the vines with Paris-green, mixed with twice its bulk of flour. The poison was applied in the morning when the dew was on. I killed thousands of bugs—in fact the ground was really covered. I could scrape them up by the handful. Many potato vines turned black and died. For every bug that died a thousand seemed to come. They ate up all my potatoes and Paris-green too. I dissent from the position that the bugs shun the presence of the Paris-green; if so they would not eat it; and I found as many on the vines that I thoroughly dusted as any. They ate them entirely up, stalks and all. L. P.

Fighting against these voracious, prolific and many-brooded insects is often, it must be confessed, very discouraging work, of which the letter just quoted gives an example, and the following case is another of a somewhat different character. One of my townsmen, Mr. John Hepworth, an industrious and careful farmer, had nearly an acre of choice potatoes, which, by frequent hand-picking he had preserved from the insects till about the middle of July, when, being driven with harvest work, he paid no farther attention to them. Two weeks later I saw these vines and they were half eaten up by the second brood of these loathsome vermin, and covered by them to such an extent that the owner abandoned them to their fate. A week later, Aug. 6, nothing but the leafless stalks remained, and the insects, mostly in the larva state, were leaving them and crawling in all directions in search for food. In this case most of the insects had come in from a neighboring potato patch which had been neglected. No doubt hundreds, if not thousands of similar cases have occurred throughout the country in the course of the past season. A timely use of the Paris-green would have gone far to save the crop in such cases. But where the potatoes have become worthless, either from necessity or neglect, there is but one resort left to procure any return from the land, and that is to plow it up in season to raise some one of the rapidly maturing crops, such as buckwheat, turnips, or Hungarian grass.

The great objection to the use of Paris-green is its virulently poisonous nature, which renders it liable to injure seriously and

even fatally, both the plants and the operator. With regard to its injury to the plants, I believe it can always be sufficiently obviated by largely diluting the poison with flour or ashes. The former is preferred, because if applied when the plants are wet with rain or dew, it makes a paste which prevents the poison from being blown from the vines. Experiments would seem to show that the poison is about equally effective upon the insects, whether diluted with five, ten, fifteen, or even twenty times its bulk of flour. And the more it can be diluted without destroying its efficacy, the less injurious, of course, it will be to the vines, and the more widely it can be diffused at the same expense.

Considering the extremely poisonous nature of this substance, and the very considerable extent to which it has been used, it is remarkable that, so far as I am aware at least, no case of death from its use as an insect-destroyer is on record. The only probable exception to this statement that has come to my knowledge was in the case of a child four years old, in my own neighborhood, who, together with a still younger brother, was taken suddenly sick with very suspicious symptoms, after playing amongst some potato vines near the house, to which Paris-green had been applied. These children were taken with griping, and vomiting, and purging of green colored matter, and in a week from the time of the attack, the older one died. This case was, to say the least, of so very suspicious a character, that it made me much more careful in using and recommending this poison, and I immediately published a caution in some of the papers against the use of it in any place to which children would be likely to resort.

With regard to to the method of applying this substance, there is no simpler and more effectual way than to shake it from a gauze bag tied to the end of a stick, the operator always taking the precaution to stand so that the wind shall not blow the powder towards him.

The remarkable success which has attended the use of the Paris-green for the destruction of the Potato-bug, has very naturally raised the query whether this poison would not be an equally effective remedy against other noxious insects, and a good many interesting experiments have been performed to test this question. Experience shows, what we indeed should suspect, that this poison is speedily fatal to all foliage-eating insects, but not to those which

live by suction. As these introduce their beak into the substance of the plant, or its fruit, and imbibe the juices, they avoid the poison which lies upon the surface. And as respects the former class, the use of the Paris-green will have to be limited to those insects which subsist upon low or herbaceous plants, as its application to trees would evidently be inconvenient, expensive and dangerous. There are at least three of our worst insect pests for which the Paris-green has been successfully used. These are the Colorado Potato-bug, the several kinds of Blister-beetles (*Lyttæ*), which are sometimes almost equally destructive to the potato, and the small, striped Cucumber-beetle (*Diabrotica vittata*), which, if not properly counteracted, often renders the cultivation of cucumbers and melons an impossibility. One of the most satisfactory reports that I have met with on this branch of the subject, is in a paper read by Mr. Barler before the Alton Horticultural Society. He applied the Paris-green mixed with four parts of flour, by means of a sifter tied to the end of a long pole, to fifteen acres of melon plants. "Absolutely every bug disappeared within twelve hours after they were dusted." I have sought for opportunities to submit this use of Paris-green to additional tests, the past season, but have not been able to find enough of these insects to serve the purposes of experiment; and Mr. Parker Earle informed me that the same scarcity of them has been noticed in the southern part of the State, and Mr. Galusha bore the same testimony respecting them in the more central section where he resides. This, at first sight, would seem to be the more remarkable, as the past hot and dry summer would have been favorable to their multiplication ; but it is not improbable that the excessive rains of the preceding year may have proved destructive to them at the propagating season.

The fear often expressed that the poisonous qualities of Paris-green will be communicated to the potatoes, may be safely dismissed as unfounded. The article has been in use long enough to have developed any such danger if it existed.

Upon the whole the Paris-green, if properly used, may be considered to be an almost infallible remedy against the Colorado Potato beetle, and many other leaf-eating insects. Any harm from its use, either to the plants or the operator, can be obviated by observing the following rules :

1. Always dilute the poison with at least ten times its bulk of flour.

2. Apply it to the plants when wet with rain or dew.

3. Never entrust its use to young or careless persons.

4. Never use it near the house where young children resort.

5. Apply it with a gauze bag or some other sifter, attached to the end of a pole.

6. Let the operator always keep upon the side from which the wind is blowing.

7. Do not apply it to any plant where it will come in contact with the fruit.

Before closing this article I wish to call the attention of agriculturists to the practicability of substituting arsenious acid, or the white powdered arsenic of commerce, for the Paris-green, for the destruction of noxious insects. The simple arsenic is a lighter substance than Paris-green, that is more bulky for the same weight, and would, therefore, go farther, pound for pound; its white color would render the extent of its application more easily visible on the green foliage, and its cost is less than one-quarter of that of Paris-green, the wholesale price of the latter being about forty cents a pound, whilst the price of arsenic is only about eight cents. If, as is generally supposed, the efficacy of Paris-green in destroying insect life depends wholly upon the arsenic in its composition, there seems to be no reason why the simpler and cheaper article should not be substituted for it. This matter was brought to my notice by an intelligent druggist, but too late in the season to put it to the test of actual experience, and I would here call attention to it as a matter well worthy of future consideration and experiment.

It is proper to add here, that with regard to this whole matter of using violent poisons to destroy insects, some judicious persons take strong ground against it; arguing that if the use of such dangerous substances becomes common, they will almost unavoidably fall into the hands of some young and careless persons, and that some valuable lives will be lost. The argument is a weighty one, and shows the necessity of great caution in the use of such articles, if not their total abandonment. It is my desire, in this report, to state, as far as possible, all the known facts bearing upon the case, and then leave it to the judgment of each one to determine for himself whether to use them or not.

INSECTS INJURIOUS TO THE ROSE.

THE ROSE-SLUG.

(*Selandria Rosæ*, Harris.)

Order of HYMENOPTERA. Family of TENTHREDINIDÆ.

Harris's Treatise, p. 525.

Few things are more distressing to a person of taste and refinement than the blasted and ruined aspect which the rose bushes, almost everywhere, have, for many years past, presented. In traveling through various parts of the State, in the course of the past summer, I have seen many gardens upon which much labor and money had been expended, rendered unsightly by the lifeless skeletons of these queenly plants, which should have been their ornament and pride. Those who suffer most from this sad spectacle are the women, who being naturally more refined than men, are, in the same proportion, greater lover of flowers. Now, if by anything that I can say, I can put the fair women of the land in the way to restore their lost darlings to their pristine life and loveliness, I have no doubt that they would unhesitatingly conclude that the office of State Entomologist is a great institution, and I should not be much surprised if they should combine to pay the salary of the incumbent, as people sometimes raise monuments to the great and the good, by the universal payment of penny contributions.

Well, I believe all this can be done—I mean the roses saved, not the monument built—at a very trifling expense, and without any great amount of labor, by the general putting in practice of knowledge which has long been had by the few, and in reiterating which I therefore lay no claim to originality. All the merit I can assume is in explaining a little more fully than our writers have

usually done, the philosophy of the thing, so that we may work understandingly and therefore effectually.

The blasted appearance of the foliage of the rose bushes is the work of a little soft, green worm, scarcely noticeable without close inspection, on account of its similarity of color to that of the leaves on which it rests. This insect is generally known as the Rose-slug. It is the larva of a small Hymenopterous or wasp-like insect, scientifically named the *Selandria Rosæ*.

In conversing with people upon this subject, I have found that many are acquainted with the insect, but very few know anything of those peculiarities in its habits upon which its successful treatment depends. If we only hastily examine a rose bush which is infested with these worms, we shall be very likely to fail to discover the agents of the mischief, for the reason that, like the majority of caterpillars, they are night-feeders, and conceal themselves during the day from their enemies, and from the heat of the sun, by retiring to the under side of the leaves. When we examine the damaged leaves more closely, we find that it is only the upper cuticle of the leaf that is eaten off; and yet, at the time when we usually look for them, they are upon the under side of the leaves—all of which is easily explained in accordance with their habits. They rest during the day upon the under side of the leaves, and reserve their appetites for their noctural foraging visits upon the upper surface.

It is evident from this brief statement that whatever applications are made use of for the purpose of destroying these insects, must be made in the evening after they have exposed themselves upon the upper side of the leaves. I regret that I did not take pains, at the proper season, to determine more particularly at what time in the evening they come upon the upper surface, and also at what time in the morning they retire. This, however, any one can easily determine for himself. If it should appear that these worms, or any part of them, remain in concealment until it is quite dark, as we have seen to be the case with the Fall Web-worm described in the second article of this report, then we should have to make our applications by moonlight, or by the light of a lantern, in order to be wholly successful, or successful in the shortest time.

The long known and established application for the destruction

of the Rose-slug is a solution of whale-oil soap. The first use of this cheap and effective article, now extensively used to destroy a variety of insects, was made many years ago by Mr. David Haggerston, of Watertown, Mass., as stated by Dr. Harris, in his Treatise, when speaking of the insect now under consideration. Mr. Haggerston used it of the strength of two pounds of the soap to fifteen gallons of water. The Hon. Lewis Ellsworth, proprietor of the Naperville nursery, and his son, who make the cultivation of roses a specialty, informed me that they find this article to be all sufficient for the purpose of destroying the Rose-slug in their green-houses and elsewhere, and that they do not find it necessary to use more than one pound to fifteen gallons of water. As it is a very coarse and disagreeably smelling article, it is of course desirable to use as weak a solution as can be without impairing its effect. It is applied with a water-pot or a garden syringe. The whale-oil soap being so effectual, it is not necessary to resort to other applications.

I will take this opportunity to state, however, that I have experimented with the carbolic acid about which so much has been said as an insect destroyer, by mixing, first, one ounce of the pure acid to one gallon of water, and afterwards two ounces to the gallon, and applying it to the Rose-slug and to the equally tender slug of the Pear-leaf, but with very unsatisfactory results. It appears from my diary, kept at the time, that the Rose-slugs were only driven temporarily from the leaves, but not killed, even by the stronger solution, and that the Pear-slugs having been dipped into it with the leaves to which they were attached, were found the next day feeding upon the same leaves, unharmed. It is probably more effectual in the form of carbolic acid soap, but whether this is any better than the cheaper whale-oil soap, I am unable to say, from any experience of my own.

There are two broods of these insects in a season; the first usually making their appearance early in June, and the other in August. But if the former be pretty thoroughly exterminated, there will be little to fear from the late brood.

I hope that the dissemination of this report may prove instrumental in calling attention to this subject, and in saving from utter destruction this favorite flower. If it should be permitted me, when another June calls the roses to blossom, to revisit the beau-

tiful grounds which I have this year seen robbed by the spoiler of half their beauty, I should deem it a most grateful consummation of my labors to see my fair country-women once more smiling and hopeful, embowered amidst their roses, and no longer mourning over their loved and lost, like Rachel, comfortless, or like Niobe, weeping.

INSECTS INJURIOUS TO THE PINE.

THE WHITE PINE LEAF-LOUSE.

(*Mytilaspis pinifoliæ*, Fitch.)

Order of HOMOPTERA. Family of COCCIDÆ.

Fitch's 1st and 2d New York Reports, page 256.

The White Pine (*Pinus Strobus* of Linnæus,) is the tallest and most valuable of our timber trees, and also one of the most highly valued for ornamental purposes. Unfortunately its balsamic and pungent qualities afford it no immunity from the attacks of destructive insects. Many distinct species and myriads of individu als find sustenance in its majestic trunk or on its almost innumerable leafets.

The species now under consideration appears in the form of little oblong, white, muscle-shaped scales, one-tenth of an inch in length, attached to the leaves, and differing but little, except in color, from the well known scales of the Oyster-shell Bark-louse of the apple tree. The insect, indeed, though it lives upon the leaves instead of the bark, belongs to the same family and the same genus as this last mentioned notorious species. I do not know that they infest the tree in its native forest, but they are very injurious to ornamental trees, not only to the White Pine proper, but also it would seem to a still greater extent, to the variety known as the Gray or Scotch Pine. They sometimes multiply so as to almost completely whiten the foliage, like a fine snow storm. They belong to the sucking, as distinguished from the gnawing division of insects, and impoverish the leaves to a greater or less extent, by imbibing their sap. The leaves turn brown and unsightly, and in some cases the whole tree presents a sickly and decaying aspect. I have noticed that the scales with which the insect covers itself assumes a different form upon the

two varieties of pine above mentioned. On the narrow leafet of the White Pine, the scale—or I should specify, for reasons which will appear hereafter—the *female* scale, has a slender and linear form, exactly corresponding to the width of the leaf on which it is moulded ; but on the broader leaf of the Scotch Pine, where it has space to expand, it may be supposed to assume its normal shape. It here often appears almost in the form of an elongated triangle with its terminal or shorter side rounded. Its generic tendency to the muscle shape is perceptible only in one of the long sides being nearly straight and the other a little more arched.

Upon a more critical examination, these scales are seen to be composed of three parts, one behind the other, gradually increasing in size, and thus marking the successive stages of the insect's growth. Mr. Walsh designated these parts, respectively, as the larval scale, the medial scale, and the anal sack. The French authors call the large terminal portion the buckler or shield, but to avoid unnecessary changes I shall, in the present article, adopt Mr. Walsh's names. Besides, the term anal sack expresses more accurately the composition of this part, it being turned under at its edges so as to inclose the insect and its eggs. But this inferior lamina is very thin, and being adherent to the surface of the leaf it is necessarily ruptured in raising the scale.

The larval scale is of a pale, transparent amber color, and a flattened, oval form, slightly elevated or carinated along the middle, with transverse furrows on each side, indicating imperfectly that division into rings or segments which characterizes all the annulose animals. The larval scale, as its name implies, is evidently the moulted skin or envelope of the insect in its primitive or larval state. In retreating from it, the insect leaves all its members attached to it.

The small, and scarcely more than rudimental legs, and the slender anal filaments become obliterated and indistinguishable as soon as the larva is fixed; but the antennæ remain and can generally be seen attached to the anterior extremity of the scale after the lapse of a year, and after the insect beneath has passed through all the phases of its existence.

In leaving its larval envelope, the insect retreats a little upon the leaf, and at the same time becomes clothed with a new integument, closely resembling the former, but a tint darker colored,

more opaque, with the segmental divisions less sharply defined, and about four times as large; that is, about twice as long and twice as broad, indicating the corresponding growth of the insect. This is the medial scale. It is, in reality, the second larval skin, and though in the course of a very short time, not exceeding a day or two, the insect beneath becomes detached from it, as it did from the first envelope, yet there is a short period when it is evidently a part of the insect itself, and cannot be detached from it without violence.

As soon as the medial scale is formed, there begins to appear from under its posterior edge, a white membraneous border, which is the commencement of the anal sack. This increases rapidly day by day, so that in from two to three weeks from the time the insect hatched from the egg, the growth of the whole scale is completed. The anal sack, when fully formed, is more than four times as large as both the former scales combined, by which I mean, as in the former case, not four times as long, but more than twice as long, and considerably more than twice as broad. It is of a pure milk-white color, beautifully contrasting with the amber colored larval and medial scales, and rendering this a really elegant little insect, notwithstanding its pernicious habits and its opprobrious name.

If we raise the scale at any time during the growth of the anal sack, we find the soft, wrinkled, memberless body of the insect itself, apparently wholly detached from the scales above, and at once suggesting the question, in what manner and from what source is the growth of the anal sack accomplished. Upon carefully examining the insect, however, with a strong magnifier, a number of fine silken threads can be detected projecting from its sides and posterior extremity, which were ruptured in the act of raising the scale, and which formed the connecting tissue between the insect and the scale above. It must be by means of these filaments that the anal sack is constructed. What strikes us as remarkable is, that so comparatively large and rapid a growth can take place through such sparse and attenuated media. We see, from this account, that the anal sack is very different in its nature from the two preceding envelopes, and never, like them, strictly constitutes a part of the insect itself.

Perhaps a correct idea of the nature of the several envelopes with which these anomalous insects are invested, may be obtained by tracing the analogy which exists between them and the successive integuments of the higher insects, more especially the caterpillars or larvæ of the nocturnal Lepidoptera. The larval and medial scales may be considered as analagous to the first and second skins of the caterpillar before and after the first moult, the most important difference between the two successive envelopes being the increase of size, in order to accommodate the insects' growth. The anal sack exhibits a remarkable analogy to the cocoon in which the caterpillar subsequently incloses itself. Neither is strictly a part of the insect, but is constructed by it solely as a means of protection. Both are constructed from silken threads secreted by the insect, with this difference: that the caterpillar constructs its cocoon with a single thread, secreted through a spinaret near the mouth, whilst the *Coccus* forms the anal sack from a number of threads produced from pores in the posterior part of its body. The analogy seems to fail in that the caterpillar leaves its cocoon upon arriving at maturity and before depositing the germs of its future progeny, whilst the *Coccus* lays her eggs beneath, or more strictly speaking, within the anal sack. But even here the analogy is maintained by certain exceptional moths, one of which, the Tussock-moth (*Orgyia lencostigma*), never wholly deserts her cocoon, but lays her eggs upon the outside of it; and another, the Basket-worm moth (*Thyridopteryx ephemeræformis* , preserves the analogy still more completely by actually depositing her eggs within her cocoon.

Such is the view which I have been led to adopt, after an almost daily examination of the development of these insects during the past summer, of the nature and formation of these scales and their component parts. The whole subject is, at first sight, abstruse and difficult, and entomologists have held a diversity of opinions concerning it. Drs. Harris and Fitch, probably from not having traced the insect through all its stages, thought that the whole scale was the dried remains of the mother insect. Dr. Shimer supposed that all the parts of the scale were the results of successive moultings, and adopted the gratuitous notion that they are cemented together by the animal's excrement; and Mr. Walsh,

whilst he corrected the errors of his predecessors, failed himself to detect the radical difference in the nature of the anal sack as compared with the larval and medial scales.

We have thus far spoken only of the female insects and their scales, but in addition to these we find upon the leaves about an equal number of a much smaller scale, being only one-half as long and scarcely half as broad; straight, linear, and carinated. This is the scale of the male insect. It is found, upon examination, to be composed of only two of the corresponding parts of the female scale, namely, the larval scale and the anal sack, the medial scale, and that stage of growth indicated by it, being absent. Accordingly it attains its growth in a shorter period than that of the female, requiring only about ten days for its completion. The male of this species is deserving of special interest, from the fact that this sex, in the more widely known Bark-louse of the apple tree, has never been discovered. From the similarity of the two species in all their important characters, so far as they are known, it is reasonable to assume that the male of the *Aspidiotus* (or as it is now called, *Mytilaspis*) *conchiformis*, if it ever be discovered, will be found to resemble, in all essential characters, the male of the Mytilaspis of the Pine.

The first sight that I obtained of this interesting insect was on the 19th of August, when, upon raising a number of the small linear scales, I detected under one of them a male individual, in a condition analagous to the pupa state, with its rudimental limbs lying flatly upon its sides, and with a short, obtuse, and but half developed style projecting from its anal extremity. On the 23d of the same month, I saw a fully developed specimen after it had emerged from its cocoon-like scale, and for two weeks following this, any number of them could be obtained by inclosing the infested leaves in a closed bottle.

It will be borne in mind that the minute larvæ of this very anomalous tribe of insects, enjoy but a very brief period of active life; that they move about over the adjacent leaves and twigs for a time, rarely exceeding two or three days from the time they leave the egg, and then fix themselves immovably. At this incipient stage of their existence the two sexes cannot be distinguished from each other. But as soon as they become fixed and begin to

develop the scales which cover them, they can be distinguished at a glance by the characteristic differences in their respective scales which we have described above. The female never afterwards leaves the scale, but attaches herself to the surface, on which she rests by means of a slender, hair-like proboscis or sucker, which we have particularly described in a former article when speaking of the Apple-tree species. She increases in size in proportion as she enlarges her protecting shield, and presents the appearance of a soft, wrinkled, footless, and apparently almost lifeless grub. She, however, fulfills, infallibly, if she be not interrupted, the few but paramount laws of her being, attains her normal development, in due time becomes impregnated, and shortly after deposits her eggs and perishes. With such unerring certainty does nature conduct her operations, in her lower walks, where she reigns supreme.

Fixed immovable to the surface on which she reposes, and hidden from view beneath the shadow of her vaulted carapace, but dimly conscious, we may presume, of some unfilled requirement of her being, the helpless female *Coccus* awaits the addresses of her unknown and invisible paramour. Nor does she wait in vain. Of all the countless myriads of these lowly creatures which congregate upon the bark of the apple tree, or whiten with their spotless phylacteries the foliage of the pine, not one, so far as we know, fails to be called to enact the offices of maternity. Nature, in the universality of her providence, takes them in her charge and ministers to their necessities, and no unloved or unfruitful virgin is permitted to languish in the halls of the *Coccidæ.*

At the same time that I was making my observations upon this insect, my friend, Mr. C. V. Riley of St. Louis, succeeded also in obtaining the perfected and hitherto unknown male of this species. The engraving at the head of this article, is the one prepared by Mr. Riley from his specimens, with a copy of which he had the kindness to furnish me.

The following is a description of the male of this species.

Length, one quarter of a line, or about one fiftieth of an inch. Color, pale red. Antennæ as long as the body, ten jointed, counting as two the stout, basal, indistinctly bi-articulated joint; the other joints elongate, somewhat equal, except the last which is a little more than half as long as the preceding, each joint with a number of bristles more than half its own length. Eyes prominent, black, with comparatively few facets. The three segments of the thorax well developed. Meso-thorax somewhat elevated above.

the pro-thorax. Scutellum large, sub-quadrate. Last segment of the abdomen abruptly narrowed and terminating in a straight awl-shaped style, as long as the abdomen. Wings two, large, lying flat upon the abdomen, and one over-lapping the other in repose, extending more than half their length beyond the tip of the abdomen; two veins, a sub-costal vein, parallel with the costa, and extending upwards of two-thirds the length of the wing, and emitting a branch near the base which runs somewhat parallel with the posterior margin, and extends more than half the length of the wing. Behind the wings are two poisers, somewhat like those of Dipterous insects, but furnished at their extremity with a slender hook-like appendage.

Middle and posterior legs approximate, situated far back and remote from the anterior pair. Tibiæ and tarsi bristly. Tarsi one-jointed but with two slight contractions which indicate three normal joints consolidated into one. The tarsi terminate in a bristle-like claw; and in addition to this are four flexible finger-like processes or digituli, slightly enlarged at their tips.

We have thus far said nothing of the times of hatching of these insects, nor of their peculiar distribution upon the foliage, upon the understanding of which their practical treatment will depend.

Unlike the Bark-louse of the apple tree, this species produces two broods in a year, and the periods of their hatching are not sharply defined, both of which circumstances will enhance the difficulty of reaching them effectively with destructive applications.

One brood, like the single brood of the Apple-species, passes the winter in the egg state, safely protected under the maternal scale. These eggs, unlike the white eggs, of the *M. conchiformis*, but similar to those of the Harris's Bark-louse of the apple-tree, and some other species, are of a blood-red color. Their number averages considerably less than those of the *M. conchiformis*. These latter, when in good condition, range all the way from forty to sixty and sometimes more, whilst those of the Pine species, so far as I have observed, do not exceed half the number. Of a considerable number of scales which I have this day examined (Nov. 15th), the number of eggs under each varied from twenty to thirty, a good average being twenty-five.

I did not commence my observations early enough to determine the precise time in the Spring when this winter clutch of eggs hatch, but it must be quite early, since by the fourth of July they have completed their development and have begun to lay their eggs for the second brood, and by the middle of July the work of deposition is completed. It is proper to remark here that the past Summer has been excessively hot and dry, and probably the dates here given may range somewhat earlier than in ordinary years. We know that the eggs of the Apple-tree Bark-

louse hatched this year at least ten days earlier than usual. But all years are sufficiently hot in mid-summer, and all the stages of these insects are accomplished with great rapidity. By the 30th of July many of the eggs of this second brood had hatched, and by the end of the first week of August about half of the eggs under each scale had hatched, and the young had fixed themselves upon the nearest leaflets, many of them settling upon the same leaflet on which they were hatched.

And now began to be apparent one of the most remarkable peculiarities in the history of these singular insects. Up to this period—about the seventh of August—nearly or quite all the eggs that had hatched, and which appeared to have been that portion of them which had been first deposited, and which consequently lay farthest from the insect's body and nearest the end of the scale, had produced only male insects, clearly indicated by the development of the small linear scales. After this period, as the remaining eggs gradually hatched, a sprinkling of the broader female scales began to appear; a few mingling with the male scales upon the same leaflet on which they had hatched, or the leaflets next adjacent, but the most of them migrating outwards upon the young or terminal whorl of leaves, on which no male insect was to be seen. And here remark the wonderful instinct displayed by these creatures, which are usually considered as occupying almost the lowest rank in the insect scale. The males, which will remain attached to the leaf but a short time, and which will soon acquire wings with which to transport themselves whithersoever they desire, attach themselves indifferently upon the first vacant space they can find, whilst the females, whose power of locomotion is limited to the first two or three days of their existence, improve this transient period to spread out upon the terminal foliage where they will find a fresh supply of nutriment, and in this way each succeeding generation comes into existence where it will find the easiest access to the youngest and freshest foliage. Amongst the many wonderful provisional instincts of insects, this is by no means the least remarkable. But wonderful and beautiful as all this is, so far as the insects are concerned, it is precisely that course of procedure which is most fatal to the tree. The eggs which produce females, and which, as we have seen, do not begin to hatch till about two weeks later

than the males, continue to hatch in a very gradual manner, some unhatched eggs being found under the scales all through the month of August, and as late as the middle of September, at which time I found a considerable number of scales, with from two to six unhatched eggs. But before the close of this month, the females from the eggs first hatched have completed their development, and have begun to deposit their eggs for the next Spring's brood. So that there is an almost continuous brood of these insects throughout these two months. I cannot perceive what is gained in the economy of this insect by this protracted hatching of the Summer brood—since the product of this brood all hybernate in the egg state—unless it be to baffle the opposition of mankind. For if they had this end expressly in view, they could not pursue a more effectual course, since it follows that at whatever time we make our applications for the purpose of destroying them, some of them will elude our assaults. If we make our applications early, the unhatched eggs will be safe beneath the maternal scale. If we make them later, those first hatched will have found protection under the scales of their own formation. The unsatisfactory results of my own experiments go to confirm this view.

On the 6th of August, that is at about the close of the hatching of the male-producing eggs, I applied to two branches of a badly infested tree, a wash, composed of common fish brine, diluted at the rate of one pint to two gallons of water, and to two other branches, the same wash, but of double the strength. Again, on the 23d of August, after the greater proportion of female producing eggs had hatched, I applied to other branches, soap-suds of the strength of one gill of soft soap to a gallon of water. I also wet a branch with water and dusted it thoroughly with unleached ashes.

Upon examining the leaves upon these several branches, late in the Fall, I could not perceive much difference in the result of the different experiments. Upon all of them could be seen, still adherent, the dead and discolored remains of a considerable number of small individuals whose development had been arrested whilst in the incipient larval state, and also a larger number which had attained their normal growth, the washes having failed to reach them for the reasons above stated. It did not appear that any of

these applications had injured the foliage much, if at all; there being some uncertainty upon the subject, from the fact that the leaves upon most of these branches had been more or less discolored by the depredations of the insects. At any rate it was evident that the resinous leaves of the Pine will bear stronger applications with impunity, than the foliage of the Apple and other common fruit trees.

The practical conclusion is, that owing to the double-brooded character of this species, and the protracted manner in which the eggs are hatched, no single application of any remedial substance will suffice, as it does in the case of the common Bark-louse of the Apple-tree. These applications will have to be made at two different seasons of the year in order to reach both broods. I have not learned at what precise time the Spring brood hatches, but any one can determine this for himself by examining them from time to time with a simple pocket lens; probably sometime in the month of May. The second brood will require attention, to simplify the matter as much as possible, once a week through the month of August.

If soap-suds be used, I would suggest making it, if practicable, of the coarse whale-oil soap, which is known to be more destructive to some species of insects than the common kind. Perhaps throwing air-slacked lime into the trees when the dew is on, would prove equally or more effectual. The way to apply washes to a tree is by means of a garden syringe, which is merely a large syringe made expressly for such purposes, by having the end perforated with many small holes, so as to throw the liquid in the form of a fine shower.

The difficulties which I have just pointed out as lying in the way of any effective counteraction of the depredations of these insects, on our own part, renders it doubly interesting and important to determine what prospect there may be of their being exterminated, or effectually held in check by the operation of natural agencies. My own observations upon this branch of the subject have been very limited in extent, but highly interesting so far as they have gone.

First, with regard to the parasitic *Chalcididæ*, I have seen in a few of the scales the round clean-cut holes made by these insects, and under others I have found the oval, pellucid larva, exactly

resembling that found under the scales upon the apple tree. It is evident, therefore, that the *Pine coccus* is subject to the attacks of some species of Chalcis fly, though apparently not as yet to any great extent.

Of the shrunken and abortive eggs, so common under the scales on the apple tree, and which are supposed to be the work of *Acari*, I have met with no well marked examples in the present species.

The most effective agent in the destruction of the *Pine coccus*, so far as my observations have extended, is the one which appeared to be the least so in the case of Oyster shell species, namely, the *Coccinellidæ* and their larvæ. I have seen whole branches covered with the scales of the *Coccus*, where scarcely one could be found that had not been gnawed into and its occupant destroyed by these predaceous insects. Most of this destruction is effected by them in their larva state, and as these, being wingless, do not move very rapidly from one part of a tree to another, it is often observable that one branch will be nearly cleaned by them whilst an adjoining one will be scarcely touched. The species of *Coccinella* which I have usually seen on the pine tree is the *Chilocorus bivulnerus*, the small black species with two red dots.

The *Coccus* of the Pine-tree has long been known to be injurious to trees cultivated for ornamental purposes, a brief account of it having been published by Dr. Fitch, as long ago as the year 1856, from specimens sent to him from trees growing in the yard of S. Francis, Esq., in the city of Springfield, in this State; and I saw, last summer, many valuable ornamental trees in that city almost ruined by what we may presume to be the lineal descendants of those identical Pine-tree parasites, and as little or nothing has been done to counteract their ravages, the only reason we know why they have not spread more extensively, and effected still greater mischief, is that they have been held in partial check by such natural enemies as those which we have just enumerated.

The present article has grown under my pen beyond the limits I contemplated, but I have not seemed to be able to state in any briefer manner the history of my observations respecting the interesting insect which is the subject of it. Besides I consider the history of one species, thoroughly elucidated, of greater value than many brief and imperfect sketches; for this reason especially, that every insect may be taken to a certain extent as a type of its ge-

nus and family, and to this extent, the history of one is the history of all.

In treating of the two species of *Coccidæ* included in this report, the *Mytilaspis conchiformis*, and the *M. pinifoliæ*, I have intended to dwell more fully upon those points in their common structure and history in the one article, which I have touched upon the more lightly in the other, so that the two articles combined, and both taken in connection with the results of the labors of my predecessors in the same field of investigation, might present a comprehensive view of the subject, not perfect indeed, but somewhat approximating to completeness.

I have mentioned, a few pages back, the wonderful instincts of the *Coccus* of the Pine, which prompts the female insects to improve the short period of their active existence, to migrate outwards upon the terminal foliage, where they and the generation succeeding them will find themselves in the midst of the greenest and freshest forage, whilst the males which are to acquire wings, and the consequent power of locomotion, fix themselves indifferently upon the first vacant space that offers; thus indicating a kind of prophetic vision utterly beyond any reach of intelligence which we can reasonably attribute to beings so low in the scale of creation. The student of entomology is continually meeting with instances of this kind, which arrest his attention and excite his wonder, and which baffle his utmost ingenuity to explain.

Permit me, by way of conclusion, to refer briefly to a few of these instances, not merely as marvellous stories, intended to excite the curiosity of children, but as remarkable facts in nature, fraught, it may be, with a profound significance.

It is the common instinct of insects which are wood-borers in their larva state, but which have no such power in their subsequent stages, to gnaw their way to the surface of the tree before they stop feeding, so that they can emerge without obstruction after they shall have completed their transformations.

The Plum-gouger (*Anthronomus prunicida*), whose history was so carefully traced by my predecessor, Mr. Walsh, and which in its larval period occupies not the flesh but the kernel of the plum, when it has completed its growth and is ready to transform in the kernel, takes the precaution to gnaw a round hole in the shell, through which it may subsequently emerge. If it did

not do so it would be fatally imprisoned, in its future beetle state, within the mature and hardened shell, an event which the Gouger carefully guards against, though the horticulturist might regard it as a consummation devoutly to be wished.

The Dissipus-butterfly (*Nymphalis disippus*, Gdt.) an interesting account of which is given by Mr. Riley, in the first volume of the American Entomologist, lives in its caterpillar state, on different kinds of willow. In this state it passes the winter, inclosed in a willow leaf, rolled into a cylindrical case. But as the leaf would fall like the rest, when touched by frost, or be blown away by the wind, the insect fastens its footstalk with silken threads to the branch on which it grows, and thus securely rides through the frosts and storms of winter.

The larvæ of a beautiful East Indian butterfly, the *Thecla Isocrates*, live in companies of half-a-dozen or more, in the fruit of the pomegranate, and there also pass the pupa state. But before changing to chrysalids, each larva cuts a round hole in the rind, through which the future butterfly, which itself has no teeth, but only a slender flexible proboscis, may be able to escape, and as the worm-eaten fruit would be likely to fall prematurely to the ground the larvæ crawl out and make the stem fast to the tree with their web and then return and go through their transformations.

Those moths whose larvæ or caterpillars are leaf eaters, always lay their eggs upon that kind of plant or tree upon which it is the nature of their future progeny to subsist, though they have no other relation to the tree, and though the eggs do not usually hatch till after the death of the parent, and sometimes not till the following year.

Many kinds of wasps exhibit a wonderful provisional instinct. The female wasp burrows into the ground or sometimes into rotten wood, constructs a cell at the bottom of the cavity and there deposits her eggs. She then carries in insects which may serve as food for her future progeny. Some species take the additional precaution to disable but not kill the insects thus provided, so that her young may find themselves provided with fresh provisions. Having completed her task she closes the hole, and never again re-visits it, but shortly after perishes.

Now are we to understand that these insects are really endowed with a prophetic vision? Do they know what will be their own

condition the next month or the next year, or what will be the future necessities of their offspring which perhaps are yet unborn? We are hardly prepared to attribute to them such superhuman intelligence. If they do not know, then what is it that prompts them to take such wise and far-reaching precautions? Who will answer? I ask the question, but I shall hear no response, for there is no earthly intelligence which can solve the mystery.

I can conceive of the formation of a planet, by the condensation of nebulous matter, in obedience to the law of gravitation. I can form some idea, however unsatisfactory, of the development of organic bodies by the operation of physical laws, responsive to the impressions of surrounding circumstances. But that an insect which was born yesterday, and which will die to-morrow, can, without the invocation of a wisdom superiors to her own, adopt a systematic course of conduct having for its object the safety and welfare of her future progeny, which will not spring into active existence till long after she herself shall have perished,—this, it passes the bounds of my imagination to conceive.

It is said that Galen was converted from Atheism by the contemplation of the human skeleton; but I confess that nothing has so strongly impressed upon my own mind the presence of an all-pervading intelligence in nature, as the wonderful prophetic instincts of insects.

SECOND ANNUAL REPORT

ON THE

NOXIOUS INSECTS

OF THE

STATE OF ILLINOIS.

BY WILLIAM LeBARON, M. D.,
STATE ENTOMOLOGIST.

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INTRODUCTION.

[Second Report.]

To His Excellency, John M. Palmer,

Governor of the State of Illinois:

Sir—I herewith transmit my second annual report upon the Noxious Insects of Illinois.

A few words are necessary, by way of introduction and explanation. It is perhaps generally known to those who take an interest in such matters that the whole of the first edition of the first annual report,—comprising five thousand copies—was burnt, in company with other state documents, in the public bindery, at Springfield, on the 23d of February, 1871. Near the close of its session, the General Assembly ordered the reprint of a part of these documents, and amongst others, the report of the State Entomologist. This reprint was made in the month of August, from a single copy, which was the only one that happened to be preserved, the manuscript also having been mislaid and lost. The printing was done without the supervision of the author, and though for the most part correct, a considerable number of slight verbal errors were overlooked which, so far as they have been detected, have been corrected under the head of *errata*, at the end of this report.

In the introduction to that report I stated my intention, as soon as the work of preparing it was off my hands, to devote my time for the remainder of the winter, to assorting and labeling the duplicates in the Walsh collection and my own, with the view of furnishing a suite of the insects of the State for the Industrial University, in compliance with one of the requirements of the law by which the office of State Entomologist was created. Accordingly, the greater part of the winter was devoted to this work, and the labeling of the specimens in the two most extensive Orders—the *Coleoptera* and the *Lepidoptera*—was completed. It was my intention to go through with the other Orders

in the course of the winter of 1871 and 1872, so as to have a tolerably full suite of the insects of the State, in all the Orders, ready to be transmitted to the Industrial University in the spring of 1872. But the element of fire, which is so terrible when beyond the reach of human control, has again thwarted my designs. The great conflagration which laid the city of Chicago in ashes, included in its fatal embrace, amongst many other fine buildings which were supposed to be fireproof, the Chicago Academy of Sciences, which contained the most valuable scientific treasures of the West, and amongst them, the extensive collection of insects known as the Walsh Cabinet. When we consider the many years which that indefatigable entomologist had devoted to the accumulation of this collection, and still more when we take into view the scientific research and the extensive correspondence and exchanges, by which he had succeeded in attaching to almost every specimen its correct scientific name, thus making it a standard of reference, not only for the entomologists of this State but of the country generally—it is a difficult task for the lover of this science to reconcile himself to this almost irreparable loss. It is a source of some consolation that the greater part of the duplicates of *Coleoptera* and *Lepidoptera*, which had been prepared for the Industrial University, had not been returned to the academy, and therefore escaped the flames. I had also at my residence two large drawers of the original cabinet, containing the families *Staphylinidæ*, *Histeridæ*, *Nitidulidæ*, *Chrysomelidæ* and *Coccinellidæ*, making, in connection with the duplicates, something like a tenth part of the whole collection.

It will be observed that the pageing of this report is made continuous with that of the preceding one. The object of this is to facilitate indexing when a number of these reports shall be bound together in one volume.

I am indebted in this, as in the former report, to Mr. C. V. Riley, for the figures which illustrate it, with the exception of those of the two Willow insects, which were engraved by Baker & Co., of Chicago, and the bug-catching machine, at the end of the volume, which was engraved at the office of the *Prairie Farmer*.

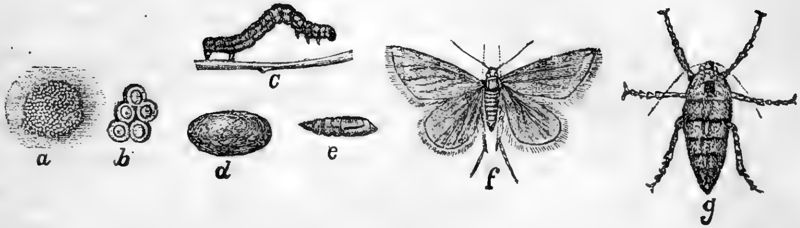
I have again to express my thanks to the managers of the leading railroads of the State for free passes over these great thoroughfares.

Respectfully submitted.

GENEVA, *December*, 1871.

WILLIAM LEBARON,
State Entomologist.

INSECTS INJURIOUS TO THE APPLE.



Explanation of figures.—*a*, the eggs; *b*, the eggs magnified; *c*, the Canker-worm or larva; *d*, the cocoon; *e*, the pupa; *f*, the male moth; *g*, the female.

THE CANKER-WORM.

(*Anisopteryx vernata*, Peck.)

Order of LEPIDOPTERA. Family of GEOMETRIDÆ.

Harris's Treatise, (Ed. 1862) page 461; Riley's 2d Rep., p. 94.

Amongst the many kinds of insects which are injurious to mankind a comparatively small number have been so extensively destructive, and have become so generally known, that they might be appropriately called, by way of distinction, first-class noxious insects.

In order to be entitled to this bad preëminence, an insect must possess a certain number and degree of obnoxious qualities. In the first place it must depredate upon some one of the more valuable productions of the soil upon which mankind depend for subsistence and profit. In the next place it must be sufficiently numerous to attract general notice, and to demand the most prompt and energetic measures for its suppression. And, thirdly, it must extend over a sufficient area of country to make itself felt, not only upon individual welfare, but also upon the commercial interests of the country.

Tried by these tests but very few of the many insects treated of in our Reports and Treatises upon noxious insects, can be admitted into this primary class; and of these some would enter without question, whilst the claim of others would be regarded as debatable. Amongst

the insects which take this rank without doubt or question, may be mentioned the Hessian-fly, the Chinch-bug, the Oyster-shell Bark-louse, the Plum-curculio, the Codling-moth, the Colorado Potato-beetle, and lastly, the notorious Canker-worm, which is the subject of the present article.

Whilst it is important to examine, describe and name all the species of noxious insects, partly for the convenience of reference, and partly because we do not know how destructive any one of them may hereafter become, yet it is chiefly by the continued and repeated investigation of the most notorious and destructive species, and the record of every fact and experiment which may throw light upon their history and the most effective means of combatting them that the entomologist can expect to render an essential service to the farmer and the horticulturist.

With this end in view, having had a good opportunity to observe the Canker-worm and the moth which produces it, during the past season, I determined to submit the habits of this notorious and long known insect, to a renewed and careful scrutiny. I am in hopes that the observations and experiments here recorded will enable us hereafter to combat this destructive insect more successfully than we have heretofore done.

ITS HISTORY.

The Canker-worm is a native American species, and is one of the longest known of our noxious insects. The earliest record of its history that I have met with is printed upon a discolored scrap of an old book, the title of which is lost, which was sent to me by Mr. Jonathan Huggins, of Macoupin county. As the extract is brief and is worth preserving on account of its antiquity, I here transcribe it:

"Canker-worms.—In the year 1789, the Rev. John Cushing, of the county of Worcester (Mass.), communicated to the Academy of Arts and Sciences, a method to destroy Canker-worms in the egg. It is as follows: In autumn, before the ground be frozen, take an iron bar and make a number of holes under each tree, near the body; thrown in a few kernels of corn into each; let in swine; and they will root the ground over and over, which will not only so disturb the eggs deposited in the ground as to destroy them, but it will be very salutary to the trees. Nothing is better to make apple-trees flourish than to have hogs turn up the ground under them.

"This method (added Mr. Cushing) I had from Mr. Edward Raymond, of Sterling, who has tried it with success."

The practical advice given in this extract is by no means devoid of value, but the writer has fallen into the error of mistaking the chrysalids of the insect for its eggs.

But, like other widely spread noxious insects, the Canker-worm has had its seasons of increase and decrease. It was very abundant in Massachusetts seventy years ago; subsequently it became almost unknown in that State for many years. It is said to have disappeared after a very heavy frost in the month of June which killed the caterpillars. But this is hardly probable of so hardy an insect as the Canker-worm. They appear to have been numerous in the vicinity of Boston in the year 1840, and several preceding years; but Dr. Harris states that from 1841 to 1847 they almost disappeared from that section, but that they rapidly increased again after the last mentioned date.

It is remarkable that several of our noxious insects which are most destitute of the means of locomotion, have become the most widely spread over the country. This is the case with the Oyster-shell Bark-louse, the White-spotted Tussock-moth, and the Canker-worm, in all of which the female is destitute of wings. The Canker-worm appears to have been first known as a noxious insect in New England, but it has now become spread over all the northern and western States, as far west as Iowa, and as far south as Missouri. I have received the past season, accounts of serious damage by them from Clinton, Wisconsin, and DuQuoin in the southern part of Illinois, and from several intermediate places. Reports of their injuries have also been communicated to the Department of Agriculture at Washington from Norfolk county, Massachusetts; from several counties in Ohio, and from Jefferson county in Iowa. In these communications they are sometimes designated as the Measuring-worm, and sometimes as the Black span-worm. But, as might be expected from the wingless character of the females, their distribution is very unequal and apparently arbitrary, a common road sometimes serving for years as a barrier between a free and an infested orchard.

DESCRIPTION.

The general appearance of this insect, in its several stages, is sufficiently obvious in the figures at the head of this article. They are of a pale gray color, and have no conspicuous markings. The wings of the male are of a very thin and flexible texture, and are usually seen more or less denuded of their scales. The females, as already stated, are wingless. They vary in length from two to five-tenths of an inch. Their

gray color is produced by short black hairs and scales, on a whitish ground. The thorax is hoary, usually with a distinct transverse black line or narrow band. Some individuals have a distinct black dorsal stripe extending the length of the body, but this is usually interrupted, and often obsolete or wanting. Their general color is so similar to that of the bark of the apple tree that they are easily overlooked, when not in motion. The proboscis is obsolete in both sexes; and these insects take no food in their imago state.

THE NATURAL HISTORY

of these insects may be briefly stated as follows: The female deposits her eggs upon various trees, but mostly upon the apple-tree and the elm. These eggs hatch in the latter part of April or beginning of May, or at about the time of the flowering of the red currant—the time varying a week or two, according to latitude and the character of the season. The caterpillars feed upon the foliage, and are often so numerous as to defoliate whole orchards of apple-trees or whole parks of elms. They attain their full growth in about one month, when they let themselves down by a thread, and burrow from two to six inches into the ground. Here they assume the chrysalis state, and remain, with a few exceptions, through the winter and until the first mild weather of spring releases them, by removing the snow and frost from the surface. They immediately make their way to the nearest tree, and crawl up its trunk. The winged males are now seen fluttering about the wingless females, and, after pairing, the females deposit their eggs and perish, thus completing the circle of their existence.

RECORD OF 1871.

I will introduce the practical treatment of this subject by a condensed record of my observations upon this insect, during the spring and summer of 1871. Such records, if carefully made, often possess an intrinsic value, inasmuch as they present the actual facts and observations upon which the opinions of the author are founded, and from which others also can draw their own inferences, and we sometimes find it convenient to refer to them for purposes which the author did not contemplate.

In the summer of 1870 my attention was called to a small orchard of apple trees, within less than a mile from my residence, which had been stript of its leaves by some kind of caterpillar. Upon visiting it I found the trees nearly bare of foliage, but not an insect could be found. They had done their work of destruction and disappeared. I had no

doubt that the Canker-worm had been the agent of the mischief, though I had never happened to have an opportunity to observe the habits of this insect where it prevailed to so large an extent.

The winter of 1870–71 was equable and mild. There was an unusual fall of snow for this section of the country, and the ground was not deeply frozen. The first week of March was remarkably warm, and the remnant of snow disappeared, except where it had been deeply drifted.

Calling the canker-worms to mind, I suspected that under these circumstances the moths would be moving early in the season.

March 7.—Upon visiting the infested orchard late in the afternoon, I found many of the male moths flying about the trunks of the trees and alighting upon them. Not a female was, as yet, to be seen. But upon looking amongst the dead grass and leaves at the foot of the trees, I found a considerable number of the wingless females, inactive and apparently torpid.

Remaining in the orchard till it began to get dark, I noticed a striking increase in the activity of the moths of both sexes. The females could now be seen emerging from their concealment, and crawling eagerly up the trunks of the nearest trees attended by, and often paired with, their fluttering mates. Visiting the orchard again the same evening after nine o'clock, with a lantern, I found the moths still traveling up the trunks of the trees and out upon the larger branches, but there did not seem to be that universal and restless activity which prevailed earlier in the evening. From this and subsequent observations, I conclude that these insects are crepuscular in their habits, rather than strictly nocturnal.

March 8.—Visited the orchard in the forenoon. Only here and there a solitary moth could be seen. But upon looking under the dead leaves and grass around the foot of the trees, and under the loose bark on the trunk and larger branches, the insects of both sexes, but especially the wingless females, were found, often crowded together torpid and motionless, and waiting for the return of night to resume their activity. Fifteen or twenty insects could be sometimes counted under one of the larger scales.

March 9.—Yesterday afternoon there occurred a violent thunderstorm with occasional heavy showers, which settled into a steady rain in the evening, and continued till near midnight. It grew cold in the night, and to-day there has been a sprinkling of snow. I was curious to see how so sudden and severe a change of the weather had affected

the Canker-worm moths, especially as most of them were not so protected, but that they must have been frequently drenched with cold rain. I could not find that any of them were seriously damaged, but only rendered a little more torpid for the time being.

March 10.—Rather cold and windy. Mercury at 45°. Visited the orchard and remained till after six o'clock in the evening. Very few moths moving; examined the ends of the lower branches of several trees, but did not see more than a dozen moths in all, and these had uniformly stationed themselves in the little crotches formed by the forks of the smaller branches or twigs.

March 11.—Caught a male flying near my house more than half a mile from the infested orchard, just before dark. Evening calm, mercury at 40°. Visited the orchard after dark with a lantern, and found the trees quite animated again with the ascending moths, many of them in pairs. Many were now seen making their way out upon the limbs of the trees, but seemed generally to stop short of the small branches.

March 13.—Examined the infested trees with the special view of determining where the eggs are deposited. Found many clusters of eggs attached to the under side of loose scales of bark on the trunk and branches; never close to the ground; sometimes, but rarely, only a few inches above it, but becoming more numerous towards the upper part of the trunk, and still more so upon the large branches. Found no eggs on the smooth branches or twigs, except where some accidental protection could be obtained. I detected some of the eggs concealed in the tufts of dead leaves produced by the Leaf-crumpler or larva of the *Phycita nebulo;* and upon further examination found that in almost every instance these tufts had been made use of by the Canker-worm moth as a depository for her eggs. In some cases the open ends of the last year's cones were found crammed full of eggs.

At this date I commenced a series of experiments with the view of preventing the ascent of the female moths, by putting around the trees bands of hay, rope and tin, which will be described more fully in the sequel.

March 15.—Very warm and showery. Mercury at 70°. Went out to the orchard just as it was getting dark and remained over an hour. I had never seen the moths so abundant. The trunks of the trees were alive with thousands of ascending moths. Indeed, the ascent of the Canker-worm moths, at the hight of their season, in a badly infested orchard, presents a most curious and animated spectacle. As evening

approaches a few straggling moths may be seen issuing from the dead grass around the foot of the tree, or from under the scales of bark where they have found shelter during the day. But as the darkness deepens the activity becomes general, and soon the trunks of the trees become alive with the multitudes of ascending moths of both sexes; the wingless females eagerly making their way up the trunk, attended by flocks of the winged males. Sometimes a female will be wholly hidden from sight under two or three superincumbent males, and her presence is only known by the steady upward progress of the fluttering mass, as she presses onward up the steep ascent, though burthened within and encumbered without, scarcely pausing for love's dalliance by the way, but dragging her partner along with her, urged by an irresistible impulse toward the accomplishment of the one grand purpose of her being: the deposition of the germs of her future progeny on the branches above, where her young, as soon as they are hatched, will be in the midst of their appropriate food.

March 16.—Weather much changed; but little above freezing; raw and misty. Examined the moths at dark, but only one here and there could be seen moving.

March 17.—Evening clear and cool. Mercury at 44°. Moths moving in considerable numbers, and upon those trees where bands of tin and hay had been put around the trunks, many moths were found congregated below the obstructions.

March 25.—Since the last date the weather has been very cold for the season, freezing at night and moderating but little by day. I have visited the orchard but once, and that in the day time. This evening, the weather having moderated, mercury at 43°, cloudy, wind east, I went out to the infested orchard an hour after dark. Moths still running, but noticed mostly below the obstructing bands.

April 7.—Weather since last date rather cold for the season. I have examined the moths a few times, but no observations of importance have been made. To-day has been very warm, mercury up to 80°; visited the orchard an hour after dark; counted thirty moths on one tree below the band; examined other trees upon which there was no obstruction. Upon only one of them a few moths were found moving, just enough to show that some stragglers continue to ascend the trees as late as the first week of April.

NUMBER OF EGGS AND PLACE OF DEPOSIT.

The female Canker-worm moths differ much in size, varying as we have stated from two to five-tenths of an inch in length, and the num-

ber of eggs laid by each individual varies accordingly. I have found in the smallest moths only fifteen or twenty eggs, whilst the largest contain from one hundred and forty to one hundred and fifty.

As the season for laying the eggs is now past, I have made a number of examinations with the view of determining definitely where the eggs are deposited. Whilst the moth of the Tent-caterpillar covers her eggs with a water proof varnish and deposits them on the exposed twigs, the Canker-worm moth does not so protect her eggs, and only secretes enough of a glutinous fluid to stick the eggs to the bark. She therefore always seeks some other protection, and this is furnished almost exclusively by the loose scales of bark. In accordance with this statement no eggs are found on the twigs or the small smooth branches. Dr. Harris states that the eggs are deposited "in the forks of the small branches, or close to the young twigs and buds." But I must conclude that Dr. Harris did not make this statement from his own observation. I have recorded above that in cold or stormy weather the female moth, after she has ascended the tree, and passed out upon the branches, often seeks the slight and only available shelter afforded by the forks of the twigs, and it was natural to expect that she would deposit her eggs there. But if she ever so deposits them, it must be very rarely and exceptionably. After a diligent search with the aid of a lens on several different occasions, upon heavily infested trees, I have never succeeded in finding any of the eggs in this situation, nor elsewhere than under the scales of bark, with the solitary exception, above referred to, of the protection afforded by the crumpled leaves and cones of the *Phycita nebulo.**

A corroboration of this view is furnished by a remark of my correspondent, Mr. J. Tinker of Wisconsin, who, speaking of these insects, which have been very destructive upon his place, incidentally remarks, "They do not bother small, smooth barked trees, either in the nursery or orchard." I may here add that, in a subsequent letter, Mr. Tinker stated that he had found the eggs of this insect in the dried apples which had adhered to the tree through the winter.

* An interesting instance of this habit of the Canker-worm moth was communicated to me by Mr. Elmer Baldwin. He stated that at one time his orchard became infested by these insects, and that at the same time the Leaf-crumplers were very numerous and troublesome, and that the moths availed themselves of the shelter thus afforded for the deposition of their eggs, to such an extent, that he regarded it as one of his most efficient modes of getting rid of the Canker-worms, to gather and destroy the crumpled nests of the *Phycitæ*—thus destroying two noxious insects by the same operation.

I have already referred to the fact that the moths deposit their eggs almost exclusively upon the inner surface of the loose scales of bark, and not upon the body of the tree. Why they should always attach their eggs to the dead bark over them, rather than to the smooth living bark under them, it is difficult to conjecture, but that they do so puts them, to a great extent, at our mercy. For it is evident that by scraping off the dead bark on the trunk and branches, any time between the laying and the hatching of the eggs, so large a proportion of the eggs will be destroyed that the comparatively few which may escape will not be numerous enough to effect any serious amount of damage. The bark and eggs thus scraped off should always be caught upon a sheet or a number of newspapers, and burned.

RECORD CONTINUED.—TIME OF HATCHING.

April 27.—About a week ago I saw a few young Canker-worms on the trees, but they were evidently premature stragglers, as the foliage had then scarcely begun to open. But to-day, the red currant being in pretty full bloom, and the leaves on some of the apple trees being half expanded, I found almost every tuft of leaves which I examined occupied by two or three minute Canker-worms.

May 11.—Canker-worms not injured by frost. The first part of May, since the Canker-worms hatched, has been cold and rainy, and on Friday the fifth, there was a sprinkling of snow, and water froze at night.

Visited the Canker-worms to-day and found them in good condition. The cold weather had, at most, only checked their growth a little. The worms vary much in size, implying that the eggs do not all hatch at once. Many of them are now three-tenths of an inch long. Noticed the ease with which they are jarred from the trees. A slight rap upon a branch will let off a shower of them, all hanging by their threads. I tried the plan of sweeping them away by passing a pole horizontally under the tree. It is evident that a vast number of them can be swept off in this way, and could be destroyed by having a brush fire at some one or more convenient points, over which the pole could be held for a few minutes.

APPROPRIATENESS OF NAME.

May 23.—Whilst looking at the apple trees blasted by this insect, I was struck with the appropriateness of their popular name of Canker-worm. By eating numerous irregular holes through the leaves, they interrupt the flow of sap, so that the leaf becomes withered and brown before it is wholly eaten, and the tree presents the appearance of having been scortched by fire.

MODE OF MIGRATING.

May 24.—Most of the worms nearly full grown, but others only half grown. Many worms are leaving the defoliated trees by hanging down upon their threads and trusting to the wind to swing them on to the neighboring trees. When the wind blows freshly, the worms are carried off nearly horizontally to a distance of many feet. I saw some to-day floating thirty feet from the tree. As the web by which they are suspended is scarcely visible, the worms often have the appearance of flying in the air. At the same time I could find very few worms on the trunk, showing that their normal way of migrating is not by crawling down the tree but by floating off on threads.

DIURNAL IN THEIR HABITS.

Whilst the parent moths are noctural or crepuscular, the larvæ are diurnal in their habits. They are seen feeding and migrating by day, and, having put twenty or more of them in a breeding cage, and examined them for a succession of nights, I always found them stationary on the leaves, and often standing off in horizontal or grotesque attitudes.

PRACTICAL TREATMENT.

I will now give a condensed statement of a series of experiments which I instituted, with the view of accomplishing the end so long sought for in combatting this insect, namely: the preventing the female moths from ascending the tree. As these females are destitute of wings, they cannot, like most other insects, fly upon the trees, but are under the necessity of crawling up the trunk, in order to deposit their eggs upon the branches above. To prevent her so doing has been the study of gardeners, fruit growers and amateurs for the greater part of a century, and yet no contrivance and no application, at once simple, cheap and effective, has ever been suggested. In the struggle for existence between man and the Canker-worm, the latter has thus far come off victorious. Many expedients have been resorted to. A leaden trough fitted around the trunk, and filled with oil, has been found the most effective, and might be used to preserve a few choice trees; but it requires considerable attention to keep it in order, and it is altogether too expensive for general use. The most common and generally approved method has been the application of a band of cloth around the tree, besmeared with some adhesive substance, which will entangle the feet of the ascending moths and hold them captive. For this purpose

tar has generally been used as most available and effective. But this method is very troublesome and unsatisfactory, when attempted to be used upon any considerable scale. The tar dries rapidly in the air, and has to be renewed as often as every other day; and when we consider that the moths sometimes commence running in the fall, and continue to do so on mild days in winter and all through the month of March, we can see that the remedy demands too much time and attention to be practiced in large orchards.

Mr. Walsh, in an article upon this subject in the "Practical Entomologist," assuming that, in order to make this remedy successful, it may be necessary to renew the tar every day from the last of October to the middle of May, with the exception of cold days in the dead of winter, so as to intercept not only the moths but also the young caterpillars that might hatch below the obstruction, goes into a calculation to show that, even at this rate, it would pay the cost, if by so doing we can save our crop of apples. I do not question his calculation as a matter of dollars and cents, but it is utterly useless, as a general principle, to recommend remedies against noxious insects which will require daily thought and attention for six months in the year, or any considerable fraction of that period. Abundant experience shows that people in general will not persevere in fighting noxious insects if the contest requires any considerable expenditure of time, thought or money. Many of them will sooner adopt the heroic treatment formerly recommended by the editor of the "New England Farmer" to the Michigan State Agricultural Society, namely: to cut down the infested trees for firewood, or leave them to die a natural death, and turn their attention to some less troublesome means of procuring a livelihood.

At about the time of commencing my observations upon the Canker-worm moth, in the spring, I received a letter from Mr. John Tinker, of Clinton, Wisconsin, to whom I have before had occasion to refer, asking for information how to fight the Canker-worm. I immediately entered into a correspondence with him, and derived some interesting information, drawn from his extensive experience with this destructive insect. Mr. Tinker states that apple-trees will perish after having been defoliated three years in succession. With respect to the orchard in which I have made my observations, I have learned that the Canker-worms first made their appearance in it four years ago, and now some of the trees are dead and others are in a dying condition. Mr. Tinker went extensively into the tarring process, and, at my suggestion, used a mixture of molasses with the tar, which he found would spread easier and retain its fluidity longer.

Mr. Tinker continues: "On account of the coldness of the weather I have had to set a tin of tar mixture in a pail, and fill the space with hot water, to make it fluid, so as to apply it with an old paint brush. My man and I run off one thousand trees this afternoon, in four hours —second coat. The first coat takes longer. Amount of material used for one thousand trees, averaging six inches in diameter, from three to four gallons. The first coat takes about five gallons."

In a former letter Mr. Tinker says: "Your letters of the 7th and 9th are received. I got my tar on the 9th, and have been into the tar and moths knee-deep since; have caught enough already to fence the farm, but whether I shall succeed in catching the rest remains to be seen. I have observed the same as you have: that they run at night, even with the thermometer at eight degrees below freezing." I have not myself had an opportunity to see them moving at so low a temperature, but the above record shows that they will run on quite cold nights, provided it be not stormy.

Later in the year, after the Canker-worm season was past, I wrote to Mr. Tinker, inquiring the result of his experiments with tar. The following extract give the substance of his reply: "My efforts held the Canker-worms somewhat in check, still they stripped a good many trees; but they left so early, and the trees growing fast, they have had a good growth of wood since. But the tar must be put on every afternoon, and the moths run this year nearly a month." He adds, substantially, that unless some plan can be invented that requires less labor and looking after, he is satisfied that human effort will not exterminate them.

Other substances, which do not harden so rapidly, have been tried as substitutes for tar. Some have used melted India rubber, and printers' ink has been recently recommended in the "Boston Journal of Chemistry." But the practical objection to all such applications is, that they have to be kept fresh not only through the whole month of March and a part of April, but also in open weather, in the late fall and winter. And Mr. Tinker's experience, like that of thousands who have preceded him, shows that such remedies are at best but partial and unsatisfactory.

It having been noticed that the Canker-worm moths climb with difficulty over a hard smooth surface, attempts have been made to intercept their progress by surrounding the trunks of the trees with strips of glass and bands of polished tin. I have repeated these experiments and find them, like many of the other methods that have been resorted to, a partial but not complete preventive. If a moth be placed

upon her back on a piece of glass, she cannot get sufficient foot-hold to turn over, and I experimented for some time with them before I saw any of them succeed in crawling up a perpendicular glass surface. But I found that they can do so, though with difficulty, and they sometimes drop off in the attempt. They adhere to smooth surfaces in the same way that the house-fly does, that is, by means of a little adhesive pad (*plantula*,) situated between the claws at the extremity of the feet, but with this difference, that the moth has but one pad to each foot, and the fly has two, and the brush of hairs upon the under side of the pad is more dense in the fly.

In the course of my experiments I made the following observations, which seem to furnish the key to a practically complete control of this notorious insect. I first tried the experiment of putting round the trunk of one of the infested trees a plain tin band four inches wide. The result is thus recorded in my diary:

March 13.—Went out at eight o'clock with a lantern to see how the experiment worked. Mercury at 34°. The moths were ascending in considerable numbers. There was a dense crowd of moths all around the tree just below the tin band. A considerable number had crawled on to it, but most of these seemed to be merely holding on without much disposition to pass over it. They were evidently baulked in their instincts. I occasionally saw one drop to the ground. A very small proportion had traveled over on to the tree above.

March 15.—Very warm. Moths very abundant, as recorded above. Tried the experiment of putting another tin band outside of the first, with a piece of inch rope between them so as to close the passage. The moths came up in crowds, but did not accumulate between the bands as I had expected, but below the inner one, as in the former experiment. It appears, therefore, that if a plain tin band, four inches wide, be put round the trunk of a tree, the moths will congregate below it, but will not freely go on to or over it. A small proportion go over, and seem to do it without any great degree of difficulty. That they do not more readily and more generally pass over, can only be explained upon the supposition that the insects are baulked or disconcerted. They find on the polished surface none of the shelter which their instincts teach them to seek for their eggs, and they are at a loss what course to take. When the instinct which impels the wingless mother of the Canker worms to make her way up the tree with such untiring zeal and pertinacity, was inscribed in the great book of Nature, the intervention of a polished tin band was not in the programme.

The moths congregrated in such numbers, one upon another, that at some points they were nearly or quite upon a level with the outer band, and the outside ones passed on to it. Upon reaching its upper edge, if the rope filling were on a level with it, they would pass over on to the tree above; but if the rope happened to be below the top of the bands, the insects would not attempt to crawl down so as to reach the rope, but would go round the edge till they came to a place where it was up to the level and then pass over. This suggested the idea that if the upper edge of the tin band were made to stand out free all around, the insects would probably be completely baulked in their ascending instincts. As the free upper edge of the outer band was the essential part of this experiment, I simplified the operation by omitting the inner band, and putting a single tin band outside of the rope band and placing it so that the rope should be about midway between its upper and lower edges. This simple contrivance seemed to be successful for all practical purposes. Comparatively few moths got on to the outside of the band, and these, upon arriving at its upper edge, and being unable to go higher, kept traveling round and round the edge until they became discouraged.

This simple method of placing a single tin band over a band of rope was adopted on the 15th of March, and though the moths continued to run in diminishing numbers all through the remainder of the month, yet only a single moth is recorded in my diary as having been seen above the band after this date.

The next practical question that arises is: what course will these egg-laden moths take if prevented from ascending the tree above a certain circle. My observations show that they will not return and deposit their eggs amongst the dead grass and leaves around the foot of the tree, as I had apprehended, nor even upon the lowermost part of the trunk; but that, faithful to their instinct, they will deposit their eggs as high up as they can get. Accordingly, I found the under side of the rope densely sprinkled with eggs, and the bark of the tree, for several inches below, almost covered by them, in many places piled upon each other. If there be loose scales of bark at hand, they will crowd the spaces beneath them with eggs, and when these fail they will adopt the only alternative the emergency admits of, and lay their eggs upon the exposed surface, though at the time they are deposited the crowded bodies of their companions must furnish a temporary shelter.

If the simple apparatus above described proves as effectual, upon further trial, as it has in my experiments, and if the intercepted moths

or the great majority of them, deposit their eggs within the space of a few inches below the obstruction, then we shall have narrowed down the practical treatment of the Canker-worm to a very small circle. The only remaining necessity will be to dispose of the eggs in such a manner that they shall not hatch, or that the worms proceeding from them shall not ascend the tree. I have proved, by experiment, the truth of what has been stated by others, that polished surfaces, such as tin and glass, furnish no obstacle to the ascent of the young worms. They walk with the utmost ease up a plate of glass, its smoothness being, in their case, simply equivalent to the absence of obstructions.

The quickest and surest remedy, therefore, is to destroy the vitality of the eggs. It has been found that the eggs of insects will often withstand much stronger applications than the insects themselves, and I have found that the eggs of the Canker worm moth may be smeared with soft-soap, or wet with a strong infusion of Paris green, without losing their vitality. But the least touch of kerosene oil is invariably fatal to them. By removing the bands, immersing the pieces of rope in boiling water, and applying kerosene to the trunk for a few inches below the band, the greater part of the eggs will be destroyed. To make the work more thorough, it will be necessary to apply the kerosene over the greater part of the trunk between the band and the ground, as some eggs are found under the bark nearly down to the ground; and this suggests the propriety of putting the band as low down as convenient, so as to circumscribe as much as possible the space to which the oil is to be applied.

But it will be asked: Will not the direct application of the kerosene injure the tree?

It seems to be generally supposed that certain strong and pungent substances cannot be applied to the bark of trees without injury. Accordingly we find that it has been the common practice in applying tar, especially the coal tar, to the trunks of apple trees, for the purpose of preventing the ascent of the Canker worm moths, to first surround the trunk with a band of coarse cloth, upon which the tar may be received. As it appeared from my experiment, that the strong applications usually made use of to destroy insects, fail to destroy the vitality of the Canker-worm eggs, whilst the least touch of kerosene is fatal to them, it became desirable to test this matter, and determine whether the direct application of kerosene oil to the trunk and branches is injurious to the tree.

For this purpose, the following experiments were performed:

On the 30th of March, before the buds had expanded, I selected two thrifty, five-year old apple trees and anointed them all over, twigs and all, with kerosene oil.

On May 9th, after the foilage had expanded, I anointed the trunk and large branches of another tree, leaving the smaller branches and foilage untouched.

On the 13th of May, with the view of making the test more general, I scraped off the rough outer bark from the trunks of a number of forest trees, three or four inches in diameter, for a space of about two feet, and thoroughly anointed them with kerosene. The trees experimented with were a white oak, a hickory, an iron wood, a thorn, and a crab-apple. I examined these trees at various times in the summer and fall, and could not find that any permanent injury had been inflicted upon them. In the case of the two young apple trees which were anointed all over, the first crop of buds were either killed or checked in their development, and these trees were several weeks later than others in leafing out. But later in the season (July 5th) these trees appeared as healthy and their foliage as full as any others.

In connection with these experiments, similar ones were made with simply greasy substances, such as lard and linseed oil, with equally harmless results.

The application of coal tar to the trunks of young trees, however, has resulted much more disastrously. Mr. Jonathan Sells, of Bloomington, imformed me that having seen it stated in an agricultural paper that the application of coal tar to the trunks of apple trees would keep off rabbits, he applied it to a space of six or eight inches high, at the bottom of the trunks of sixty apple trees, six years old from the graft, and every tree was killed and subsequently dug up.

How can we explain the difference in these two results? Was it that the coal tar is so much the more powerful and injurious in its effects, or was it due to the difference in the time of the year when the applications were made?

I wrote with reference to this point to my friend, Mr. Tinker, whose large experience in these matters renders his opinion of much value, and in his reply, under date of September 12, he says: "I have seen young trees injured by coal tar, put on in the winter to keep off rabbits, but I think any thing will injure a tree more, put on when the sap is dormant, than when growing." He adds that he has found pine

tar entirely harmless, but that it dries so rapidly that it requires to be renewed every day.

With regard to the particular point now under consideration, however, namely: the application of kerosene oil to the trunks of trees for the purpose of destroying the eggs of the Canker-worm moth, my own experiments, above detailed, seem to show conclusively that it is entirely harmless, at least, in the spring of the year; and this is the time when it is to be applied for this purpose. But a reasonable caution as to the extent of its application should be exercised, until tested by further experience.

NATURAL ENEMIES.

These insects have been observed to be destroyed by birds, by a number of predaceous ground beetles, and by several species of parasitic flies. My own observations upon this branch of the subject have been very limited, and mostly of a negative character. I have seen no natural enemies preying upon them to any appreciable extent. I have seen black ants carrying Canker-worms down the trunks of the trees, sometimes larger than their own bodies, but only in occasional instances.

I have also seen, under the same scales with the eggs, large numbers of a sub-globular smooth, brownish-black *acarus* or mite. This is similar to, and perhaps indentical with, the species referred to by Dr. Packard under the name of *Nothrus ovivorus*, and which he says he has seen sucking the eggs of the Canker-worm. My correspondent, Mr. Tinker, also called my attention to them, and said he suspected that they destroyed the eggs, as he had observed some of these to be shrunken where the mites were present. I have repeatedly examined these acari, but have never detected them in the act of sucking the eggs. I have also kept quantities of eggs and acari shut up together in a box for days, but in due time the eggs nearly or quite all hatched. I have also found the same acari in equal numbers under bark where there were no Canker-worms. My own observations, therefore, do not lead me to attach much importance to them as Canker-worm destroyers.

SUMMARY OF REMEDIES.

The following remedies against this insect are given in the order in which they are to be applied, commencing with the appearance of the moths in the spring.

1st. Prevent the passage of the moths up the trees. The most approved plan heretofore used, is to put a canvass or other cloth band, six

inches or more wide, around the trunk and besmear it with tar, or a mixture of tar and molasses, applied every other day. Roofing felt besmeared with refuse printers' ink has been recently suggested as preferable. The method suggested in this Report is, to put a band of rope or closely twisted hay around the trunk, and over this a tin band about four inches wide, placed so that the rope shall be at the middle of the tin, making a closed cavity below and a free edge of the tin above. The time to use these appliances is, mostly, in the month of March; but also at other times when the weather is sufficiently open to permit the insects to run.

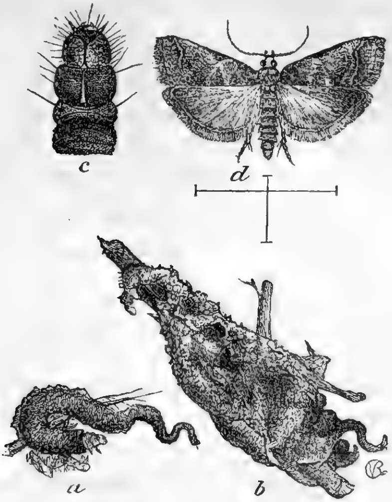
2d. If the moths are prevented from ascending the tree they will deposit their eggs below the obstruction, and for the most part near to it. These eggs can be destroyed by a single application of kerosene oil.

3d. If the moths are not prevented from ascending the tree they will deposit their eggs mostly upon the under side of the loose scales of bark on the upper part of the trunk and the large branches. Many of these can be destroyed by scraping off and burning the scales.

4th. If all precautions have been neglected, and the eggs have been permitted to hatch, then, as soon as the worms are large enough to be easily seen, jar them from the trees and sweep them away with a pole, as they hang by their threads, and burn or otherwise destroy them. Strong washes, such as Paris green water, or suds made from the whale oil soap, thrown upon the trees with a garden syringe, will also materially check their depredations.

5th. If the worms have matured and gone into the ground for winter quarters, plow the ground late in the fall, so as to expose the pupæ to frost and the action of natural enemies. The effectiveness of the plowing will be increased if a few handfuls of corn be plowed in under each tree, and the hogs be permitted to have the range of the orchard.

The method of putting on the tin and rope bands mentioned in the first paragraph is very simple. Take a piece of inch rope—old worn out rope is just as good as new—tack one end to the trunk, two feet or less from the ground, with a shingle nail, driven in so that the head shall not project beyond the level of the rope; bring the rope round the tree and let it lap by the beginning an inch or two; cut it off, and fasten it in the same manner. Get the tin-man to cut up some sheets of tin into strips four inches wide, and fasten them together end-wise, so that they shall be long enough to go round the trees over the rope band, having the rope at the middle. Let the ends of the tin lap a little, punch a whole through them and fasten them with a nail driven through the tin and rope into the tree.



Explanation of the figures.—*a*, the worm in its twisted case; *b*, a crumpled mass of leaves containing a number of worms; *c*, the anterior part of the worm or larva, magnified; *d*, the perfect or winged insect.

THE APPLE AND WALNUT LEAF-CRUMPLERS.

(*Phycita nebulo, and Phycita juglandis.*)

Order of LEPIDOPTERA. Family of TINEIDÆ.

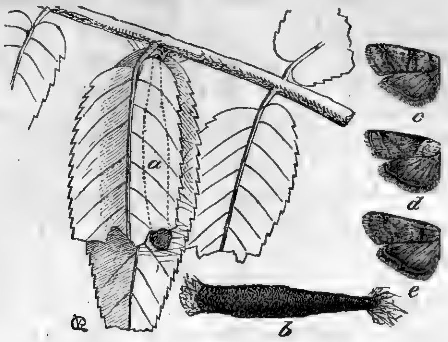
As the second of the above-named insects is of a scientific rather than a practical interest, we have not thought it worth while to make it the subject of a separate article, but to treat of it in connection with its congener, the well-known Leaf-crumpler of the apple-tree. We have been confirmed in this course, we will not say by the opinion, but rather by the suspicion that these insects may ultimately prove to be only plant-varieties, or, to use Mr. Walsh's more expressive term, *phytophagic* varieties of one and the same species But this point we shall treat of more fully in the sequel.

Phycita nebulo is the scientific name of the little gray moth whose larva forms those tufts of dead crumpled leaves which adhere to the twigs of apple and plum trees all winter, and with which every orchardist is familiar. The first account of this insect was written by the author of the present Report, and published in the September number of the "Prairie Farmer" for the year 1853. As this account gives a brief and comprehensive outline of this insect's history, we here reproduce it:

"The Apple-Tree and Plum-Tree Leaf-Crumpler.—This insect passes the winter in a half-grown larva state, and is rendered very conspicuous at this season by the little clusters of dried leaves attached to the twigs of the apple and plum-trees in which the larvæ lie concealed, sometimes singly, but often two or three in company. Besides the covering of dead leaves, each larva is enclosed in an elongated, conical and somewhat twisted case, rough externally, but of fine texture and polished surface within. As soon as the foliage expands in the spring, the caterpillar begins to devour the leaves in its immediate vicinity, drawing them in around itself, and confining them there by threads of web. It is thus enabled to feed at ease, by protruding its body partially from the larger and open extremity of its case. The larva arrives at maturity about the end of June. It is then about two-thirds of an inch long, sixteen-footed, pale dull green, with a brown head. It now slightly closes the mouth of its case, and changes into the chrysalis state. Before the middle of July the perfect insects begin to make their appearance in the form of small gray moths belonging to the family Tineidæ. The antennæ setaceous and simple; labial palpi long and recurved; maxillary palpi short and distinct; wings narrow and applied to the sides of the body when at rest; length four and a half lines, or less than half an inch; color light gray, slightly varied above with brown; across the end of the wings are three oblique blackish lines, the terminal one consisting of a series of black points."

Subsequently, in May, 1860, Mr. Walsh, not having noticed this account, published in the same journal another sketch of this insect, accompanied with an imperfect figure, and for the first time gave the species the scientific name which it now bears.

Mr. Walsh designated this insect by the popular name of the "rascally leaf-crumpler," and to another insect which he described he applied the epithet of "the hateful grasshopper." Such terms cannot meet with general approval. However injurious or obnoxious some insects may be to us, the application to them of epithets indicative of rascality or malignity is incorrect, and repugnant to good taste. The term *bogus*, also, applied to certain insects because persons ignorant of entomology have mistaken them for other and more notorious species, is equally objectionable. The specific term *nebulo* means the same thing as the English cognomen, but being couched in one of the dead languages, it is perhaps admissible, more especially as it certainly possesses the merit of euphony.



Explanation.—*a*, the larva in its case suspended between two leaves; the dotted lines show the position of the case behind the leaf; *b*, the case seen separately; *c*, the wings of *Phycita nebulo*; *d*, wings of *Phycita juglandis*; *e*, wings of a variety of *P. nebulo* bred on the crab-apple.

Phycita Juglandis, N. Sp.

The insect to which I have given the specific name of *juglandis*, lives in its larva state upon the hickory and black-walnut. The principal interest that attaches to it lies in its close relationship to the species just described, involving the curious question of identity of species, under diversity, not only of the coloration of the imago, but also of the food-plant and habits of the larva.

The moth is a much plainer insect than the apple-tree species; for whilst the latter, though tinted with subdued colors, is rather prettily variegated, the walnut species is a plain cinereous or ash-gray moth, with its markings so obscure and obsolete that, in most individuals, they can scarcely be detected. I have before me at the present moment five specimens of the *Phycita nebulo*, and fifteen of the *P. juglandis*, twelve of which I bred from larvæ taken from the black-walnut, and three are from the Walsh cabinet, marked as having been obtained from the hickory. These last have their markings rather more distinct than those from the black-walnut, but much less so than those of the genuine *nebulo*. If we compare the *P. nebulo* with the average specimens of the *P. juglandis*, their specific identity could scarcely be suspected. But if we take the best developed specimens of the latter, and select the most characteristic marks of each of them, we can make up an imaginary individual which would present a considerable similarity of pattern to that of the genuine *P. nebulo*.

But it is in the habits of the larvæ, and the form and mode of attachment of its case, that the most striking differences are observed.

The larvæ themselves are small, almost naked or hairless worms, and bear a close resemblance to each other, differing only slightly in size and color; those of the *nebulo* being a little larger and usually of a reddish-brown color, while those of the *juglandis* often incline to a dull green. They both inhabit cases which they construct of web, into which is compactly woven the little hard, dry particles of their castings. The cone of the *nebulo* is of a brown color, a spiral or twisted form, and is often attached by its whole broad side to the twig. That of the *juglandis* is of a slate-black color and more compact structure; of a straight form, and invariably suspended by its smaller extremity. The cases of the *nebulo* are sometimes attached directly to the twig, lying around it in a spiral form, but they are usually found in companies, or two or three in a clump of crumpled and partially eaten leaves; but in this case they take the precaution to anchor their cones by a strong silken cable to the permanent twig from which the leaves proceed.

The habits of the larva of the black-walnut species is in striking contrast with this. As soon as the leaves are about half grown, in the spring, it leaves the twig to which it has been attached through the winter, and passes out upon the central or common leaf-stalk of the long pinnate leaves of the black-walnut, usually to about the middle of its length, and suspends its case invariably between the bases of two opposite leaflets, and these it draws down and ties together so as to form a kind of roof above it. Upon these leaves it feeds, always commencing with the tips, so as not to disturb the connection of the leaf with the stalk. I have seen at least a hundred of these larvæ in their cases, but never saw but one on the same leaf.

It is an unsettled question whether the larva takes its case with it, when it migrates, or leaves it and constructs a new one. Mr. Walsh speaks of the larva of *P. nebulo*, as traveling from limb to limb, and carrying its case with it. But he gives no details, and leaves it doubtful whether he had actually seen the insect so migrating, or only inferred that it did so. It is the instinct of these insects to tie their cases securely to the tree, and they could not move them from place to place without an elaborate separation; and that they are capable of constructing a new cone, I have repeatedly proved in the case of the larvæ of the *P. juglandis*, by taking them from their cones and placing them naked upon another leaf. In the course of twenty-four hours they were usually found to have constructed or commenced, at least, a new cone, locating it in the ordinary position, at the junction of two opposite leaflets.

NATURAL AND ARTIFICIAL REMEDIES.

The *Phycita nebulo* may be called a troublesome, rather than a very noxious insect. They always render the trees unsightly by the tufts of crumpled leaves which they tie together and partially devour; and they sometimes multiply so as to considerably damage young trees. If they are unusually numerous they can be checked, to some extent, by throwing air-slaked lime, soap suds, or Paris green water upon the trees; not by any direct injury to them, for they are so protected, both by their cases and the crumpled leaves, that such applications could scarcely reach them—but by rendering the foliage distasteful or poisonous to them. But the true remedy is to pick off the crumpled leaves, with the inclosed larvæ, in the winter or early spring, at which times they form conspicuous objects upon the leafless trees.

In a recent article upon this insect, in the "Prairie Farmer," by Mr. B. D. Wier, a very good suggestion is made, namely: that the crumpled leaves and the inclosed worms should not be burned or otherwise destroyed, but that they should be taken to some distance from the fruit trees which they are known to infest, and there left unharmed. The result will be that the worms will starve, whilst the useful parasites will be permitted to escape.

As a general rule, however, they may be safely left to the operation of natural agencies. Both birds and parasitic insects prey upon them to a very considerable extent. Mr. Walsh reared a species of *Tachina* from them, but said he had detected no parasitic Ichneumon-fly infesting them. Last winter Mr. B. D. Wier sent me some of the cones of this insect infested by small white worms, which were evidently the larvæ of some *Hymenopterous* insect; and in the summer following, from about two dozen cones, I obtained but three moths (July 7th, 12th and 16th). The rest were destroyed by parasites, of which I obtained two Ichneumon-flies of the same species, upward of a dozen individuals of a minute Chalcis-fly, and three specimens of a small species of *Tachina*. So that, notwithstanding their natural protections, they appear to have their full share of parasitic enemies.

Winter birds also feed upon them. Mr. A. R. Whitney, of Franklin Grove, stated to me that these insects have been much less numerous in his nursery of late years than formerly. He said that he had often seen quails jump two feet and upwards from the ground and seize the crumpled leaves in which these worms were concealed, and that he had seen numbers of these tufts scattered upon the ground

between the nursery rows, from which the insects had been pecked by these birds. Mr. Whitney further remarked that he had noticed that a considerable fall of snow would give the quails a vantage ground which enabled them to obtain those worms which were, ordinarily, above their reach.

With respect to the parasites of the *P. juglandis*, I may here state that I have bred from their cones two distinct species of Ichneumon-fly, one of which was different from the species obtained from the *Phycita nebulo*.

THE QUESTION OF SPECIFIC IDENTITY.

Whether the insects here described (and the question applies equally to many other similar cases), be distinct species, or only plant varieties of the same, is at present merely a matter of conjecture, or of personal opinion. The question could be definitely settled only by a series of experiments, extending through a long period of time, in which the insects should be changed from one kind of plant-food to the other, and notice taken whether there were a gradual tendency to those variations which we now see to exist.

The whole subject of the variation of species according to difference of location, food, and other circumstances, is one which is attracting much attention amongst naturalists at the present day. It involves the important question whether there really be in nature any such thing as species, in the ordinary acceptation of that term ; that is, whether there be any definite and permanent forms which have existed in the indefinite past, subject, as a general rule, only to slight variation, and always tending to return to the original and normal type ; or whether what we call species are only varieties of a comparatively more permanent form, and this permanency owing simply to the force of circumstances, and not to any inherent law of their being.

The subject is also of interest as having an important bearing upon what has been heretofore known as the development theory, but which is at present more commonly called the Darwinian theory, after the name of its most able and popular expounder. Every well-attested fact which shows the gradual and constant change of organized forms, tends to open the way for a more general reception of this theory, by showing that our pre-conceived notions of the original creation of species, essentially in the forms in which they now exist, cannot be maintained. But this is not the place to discuss these profound and difficult questions in the philosophy of natural history. It has been our object

here only to carefully observe, and put on record, a few of the data upon which the settlement of such questions must ultimately depend.

DESCRIPTION.

Length, three-tenths of an inch. Expanse of wings, seven-tenths, cinereous. Top of the head, collar and tegulæ, in some specimens, almost white. Fore wings cinereous, with nearly the basal third usually paler; a large triangular blackish spot on the middle of the costa, just beyond which and nearly in the middle of the wing are two black dots, placed transversely; about one-fourth from the end of the wing is a very obscure blackish double bar, and still nearer the tip an obscure row of blackish dots; on the posterior part of the wing, or that part which is opposite the costa, are two rather large pale brick colored spots, one at the base and the other one-third of the way to the tip. Hind wings paler, somewhat dusky towards the tip. Abdomen inclining to pale buff, more or less distinctly fasciate with black at the bases of the segments.

All the above characters, except the occasional whitish on the head and thorax and the paler base of the fore wings, are found much more conspicuously on the *Phycita nebulo.* Indeed, these marks are usually either wholly or partially indistinguishable on the *P. juglandis*, and it would be scarcely possible to distinguish the two insects by any verbal description, if we did not take into account their very distinctive characters and habits in the larva state. As these characters are well exhibited in the accompanying figures, it will not be necessary to describe them more fully than we have already done in the body of the article. We may also add, as a pretty constant distinctive mark between the two moths, that the two dots on the disk of the upper wing in *P. juglandis* almost always run together in *P. nebulo*, forming a very short, black, transverse bar.

All the Ichneumon-flies which I bred from these insects I passed over to Mr. Riley, who will describe them in his next annual report.

The Tachina-fly, above spoken of as having been bred from the larvæ of *Phycita nebulo*, I describe below.

DIPTEROUS PARASITE OF PHYCITA NEBULO.
(*Tachina* (*Exorista*) *phycitæ*, n. sp.)

MALE—Length, 0.20 inch, or two-tenths of an inch. Antennæ black; third joint twice as long as the second. Face silvery, without bristles at the sides; sides of the front with a dull golden tint, becoming silvery at its junction with the face; the middle black vitta occupying a little more than half of the interocular space; frontal bristles continued down the face to opposite the junction of the second and third joints of the antennæ. Palpi blackish brown. Eyes hairy. Thorax black, with the ordinary cinereous stripes scarcely perceptible. Abdomen black, varied with cinereous at the bases of the segments; a large fulvous spot on the side of the abdomen, occupying nearly the whole of the side of the second segment, about half of the third, and sometimes a small spot on the first; bristles on the middle, as well as at the end, of the second and third segments. Venation of the wings of the usual type; first posterior cell almost closed before the end of the wing; fourth long vein slightly curved beyond the angle; fifth long vein prolonged to the margin; hind cross vein moderately curved. Tarsal claws and pulvilli unusually long.

FEMALE—A single specimen, a very little larger than the others, was obtained from the same lot of *Phycitæ*, which may be the female of this species. It differs as follows: Front broader. Antennæ inclining to brown. The cinereous markings on the body more distinct. The tip of the abdomen fulvous, but without the fulvous spot on the side, and with the tarsal claws of the usual length.

This species appears to belong to the sub-genus *Exorista*, of Meigen, closely allied to Tachina proper, and differing from it chiefly in having the eyes hairy, and in the presence of bristles on the middle of the second and third abdominal segments, as well as at their posterior margins, whilst Tachina has only the latter.

The following table exhibits the distinctive characters of the three closely allied sub-genera, Tachina, Exorista and Lydella:

Third joint of the antennæ about twice as long as the second. Face nearly vertical, with few or no bristles at the sides.

Eyes naked. Stout bristles at the hind margin only of the second and third abdominal segments .... Tachina.

Eyes hairy. Stout bristles on the hind margin and middle of the abdominal segments .... Exorista.

Third joint of the antennæ three times as long as the second. Face oblique, bristled at the sides. Eyes generally hairy. Usually two bristles on the middle of the second and third abdominal segments .... Lydella.

PERIODICAL CICADA.

(*Cicada Septendecim.* Linn.)

Order of HOMOPTERA. Family of CICADIDÆ.

Harris' Treatise, page 206; Fitch's First Report, page 38; Riley's First Report, page 18.

The year 1871 has witnessed one of the periodical returns in Northern Illinois and the borders of the contiguous States, of this notorious insect, more commonly known by the name of the Seventeen-year Locust.

In several respects this is one of the most remarkable and anomalous of the insect tribes. Its unprecedented longevity in its larval state and subterranean abode, the regular periodicity of its appearance, and the elaborate and systematic deposition of its eggs in the twigs of trees, often near the summit of forest trees, whilst the young hatched from them live exclusively in the earth, are all ca culated to attach a peculiar interest to the history of the Cicada.

The history and habits of this insect after it has emerged from the earth and assumed its winged form, have been pretty thoroughly traced by the authors enumerated at the head of this article, and by many other observers. To those authors the reader is referred for a detailed account of this insect. We shall, in the present article, confine ourselves chiefly to a record of the observations made during the season, and especially to such facts as bear upon unsettled points in its history.

GEOGRAPHICAL RANGE.

Amongst the many remarkable circumstances in the history of the Periodical Cicada, is the great extent of country in which they have

at one time or another prevailed. Their appearance has been recorded, within the last two hundred and forty years, over the whole extent of the United States, from Massachusetts to Florida, on the East; North, to Michigan and Wisconsin; South, to the Gulf States; West, to parts of Kansas and Nebraska; and South-west, to Louisiana and Texas. And as it is now known that during all the intermediate periods these insects are maturing under ground, at the depth of from one and a half to six feet, we must conclude that all parts of the country where trees suitable for the deposit of their eggs have grown, are, at all times, undermined by the larvæ or grubs of this insect, in different stages of development. It must not be understood, however, that they are equally abundant in all places.

Sometimes two broods appear in different sections of the country in the same year. These have been described as the brood of such a year. But it is evident that when these insects prevail in two or more places, remote from each other, they must constitute distinct broods, and should be designated by their locality in connection with the year.

NUMBER AND DEPOSITION OF EGGS.

The eggs of the locust are laid in the twigs of all deciduous trees, and sometimes, though rarely, in evergreens. They are deposited in grooves, cut through the bark and into the solid wood of the twig, by the finely saw-toothed ovipositor of the female insect. In performing this operation she clings to the twig, with her back downward, and consequently lays her eggs in the under side of the twig. Without changing her position she cuts, or rather saws, two grooves, side by side, but slightly diverging at their further extremities, leaving a wedge-shaped partition of wood between the two cells. When thrust into the twig, the ovipositor throws up a little bundle of finely separated woody fibres, free at one extremity, which secures a passage for the young insects, by preventing the bark from closing over the cavity—just as the surgeon prevents an opened abcess from closing too soon, by placing a linen tent between the lips of the wound. The female deposits about a dozen oblong whitish eggs, less than the twelfth of an inch long, in each cell, placing them two and two, at an angle of about 45°, lapping upon each other, and pointing towards the loose and open end of the splintered fibres, directly under which they are placed. After filling the two cavities with eggs, she moves on a few steps and makes two other cavities, and so on till her store of eggs is exhausted. The number of eggs laid by each female is about four hundred. In those

which I have dissected I have found them to vary from three hundred and eighty to four hundred and twenty.

TIME AND CONDITIONS OF HATCHING.

Mr. Riley states that in the region of Saint Louis the eggs of the Seventeen-year Cicada hatch from the 20th of July to the 1st of August. In the latitude of Chicago some of them remain unhatched a month, at least, later. On the 24th, and again on the 28th, of August, I saw individuals in the act of hatching, though in most instances only empty egg shells could be found.

As the young locusts obtain their subsistence not on the tree but in the earth, and as many of the twigs stung by the parent insects break off and fall to the ground, carrying the eggs with them, it has been commonly supposed that this constitutes a part of the natural economy of the insect; but this supposition proves to be erroneous. On the contrary, it is found that in the twigs which die, whether they fall to the ground or hang upon the tree, the eggs do not come to maturity, the moisture of the growing twig seeming to be essential to the development of the eggs.

Upon examining the eggs in many twigs, in the latter part of August, I found, quite uniformly, that in the living twigs the young had hatched and gone, leaving only the white membranous envelopes behind, whilst in the dead twigs the eggs were unhatched, somewhat shrunken, and of a pale-brownish or amber color. Some exceptional cases are seen, where vacant eggs shells are found in dead twigs; but these cases can be plausibly explained, upon the supposition that though the twigs ultimately perished they retained their vitality long enough to perfect the enclosed eggs. The sound egg, when near the time of hatching, can always be distinguished from the abortive eggs, not only by their whiter color, but more definitely by the presence of two distinct dark-red spots at one extremity, which are produced by the eyes of the enclosed insect showing through the thin envelope.

The death of the twig is caused simply by the mechanical violence done to them in the act of depositing. Accordingly it is usually only the small terminal part of a twig that perishes, whilst the stouter basal part, which is proportionately less damaged, survives.

These insects also sometimes, but rarely, perish in the egg from the opposite cause, namely: the too rapid growth of the twig in which they are deposited. This sometimes occurs in thrifty young apple-trees, and in twigs of considerable size, usually as large as a man's finger, where the injury caused by the deposition of the eggs has not been suf-

ficient to check, materially, the growth of the branch. In such cases the twigs grow so rapidly that, in the course of the month which intervenes between the time of the laying and the hatching of the eggs, the wound heals completely over, the tent of splinters is nearly or quite over grown, and the young insects never emerge from the eggs, being enclosed in a living sepulchre.

LARVAL HISTORY.

Of the protracted subterranean life of these insects in their larva state, of the nature of their food, the depth to which they usually penetrate, and the extent of their underground migrations, we know almost nothing. The following is a condensed statement of the past record upon this subject:

In the year 1846 Miss Margaretta H. Morris, of Germantown, Penn., found a number of locusts in their larva state, and varying from a quarter of an inch to an inch in length, attached to the roots of some languishing pear trees. But if this is their habit, it is remarkable that no similar observations have been made by others. And the statement that an insect so regular in its development as the Cicada was found of such different sizes, would render the identity of the insect questionable, were it not for the well known accuracy of this lady in her entomological observations.

Mr. R. W. Kennicott, of West Northfield, Illinois, wrote to Dr. Fitch that in following down a foot or more, in the month of November, the roots of several trees and shrubs, the twigs of which had been badly cut to pieces by the locusts of the previous year, he could find no trace of the insects. But this is only negative testimony, and the insects, at this period, must have been so small that they might have been easily overlooked.

Dr. Gideon B. Smith, of Baltimore, who made extensive observations upon these insects, held the opinion that these grubs subsist exclusively upon the moisture which exudes from the surface of the vegetables radicles which permeate the earth.

He says, "It takes its food from the surface of these roots by means of three exceedingly delicate capillaries or hairs which project from the tube of the snout, and sweep over the surface, gathering up the minute drops of moisture. This is its only food. The mode of taking it can be seen with a good glass."

I have no means of knowing the method, or extent, or accuracy of Dr. Smith's observations, but if the above account is correct, the way in which this insect takes its food is as anomalous as many other por-

tions of its history. The only instance that I know of, in the history of insects, at all resembling it, is the lapping of the honey of flowers by some of the *Hymenoptera.*

As Dr. Smith is the only one who has recorded any observations upon the larval history of these insects, I will extract a few additional items of interest from his account, more especially as his observations are not published in any work of ordinary reference. He says that they occupy oblong cells in the earth, from one to three inches in length, in which the insect freely moves. When the food to which this cell gives access is exhausted, the insect moves gradually into fresh earth by digging from one end of its cell and throwing the loose earth back into the other end. The depth to which they usually penetrate into the earth has not been satisfactorily determined. One of my correspondents who plowed up large numbers of them in the spring, found that he could trace their holes down about a foot and a half; and Dr. Smith states that he has frequently found them from one to two and a half feet from the surface of the ground. But there are many well attested cases on record of their being found from three to six feet, and in one case ten feet below the surface. The following additional cases have come to my knowledge. Mr. Charles W. Woolston stated to me that he found them six feet under ground whilst digging a roadway through the side of a hill. Mr. Geo. S. Haskell, of Rockford, saw them come up through the bottom of a cellar in the latter part of April. And Dr. N. S. Read, of Chandlersville, in Cass county, writes, that whilst examining some mounds on the bluffs of the Sangamon river, in the spring, he found fully grown grubs of the *Cicada* five feet below the surface.

Mr. Henry W. Searls gave me the following more explicit statement. Whilst digging a vault in connection with one of the public school houses in this town, on the fifth of September, 1868, he found the locust grubs four feet from the surface. The ground was so hard that it had to be loosened with a pick axe. The grubs were nearly fully grown, rather softer and paler than the mature grubs, but active and apparently in good condition. It will be observed that this was three years before the period of their maturity. The date of the observation is also worthy of particular notice as it serves to fill an important gap in their history. In the accounts of these cases it has usually been omitted to state the time of year when the observations were made, and therefore we have been left in doubt whether the insects had probably retired to these depths for winter quarters, or were living and feeding

so far under ground in the active period of the year. The latter must be supposed to have been the case, in the present instance, the insects having been found as early as the fifth of September. Such facts, taken in connection with the circumstance that vegetation does not usually appear to suffer from their subterranean feeding, go to show that their usual range is several feet below the surface. But this only leaves the nature of their food involved in the greater uncertainty.

Such accounts as these are very unsatisfactory, but they may serve to draw attention to those parts of the Cicada's history which most stand in need of elucidation.

TIME OF APPEARANCE AND DISAPPEARANCE.

A period of from five to six weeks covers the whole time in which the Cicadas are seen in their perfect or winged state. At the time of the appearance of the more southern brood in 1868, Mr. Riley states that he saw the first Cicada on the 22d of May, and that none were to be seen after the fourth of July. My observation of the northern brood coincides almost precisely with this—having seen the first on May 23d, and the last on the 1st of July. Mr. Wier wrote to me that he first saw them on southern exposures, at Lacon, on the 19th of May. Dr. Smith states, that in Maryland and Pennsylvania, their time of emergence from the ground was from the 20th to the 25th of May, thus corresponding precisely with the periods recorded above, and showing a remarkable uniformity in the time of their appearance in different latitudes, and remote localities. Straggling individuals, however, continue to emerge long after their general appearance. I saw instances of this as late as the 12th and the 17th of June.

GEOGRAPHICAL EXTENT OF THE BROOD OF 1871.

A good deal of interest has heretofore been taken by others as well as entomologists, in tracing the geographical outlines of the different broods of the so-called 17-year locust. It seemed, therefore, to be one of the special duties of the State Entomologist of Illinois, in the season of 1871, to determine, as nearly as possible, the range of the present brood, and to make a record of it, which may be consulted by those who may take an interest in this matter, seventeen years hence. I have, therefore, entered into a somewhat extensive correspondence upon this subject, with persons in different parts of this and the neighboring States. The following is a condensed statement of the results of these inquiries:

In the "Prairie Farmer" for July 29th, a brief outline of the locust range was published by Mr. Suel Foster, of Muscatine, Iowa; but in this outline, as Mr. Foster himself stated, many gaps were left undetermined. I have found Mr. Foster's outline to be, in the main, correct, and have filled, as far as possible, the gaps which he left. I will take the same starting point with Mr. Foster, namely, the junction of the Iowa river with the Mississippi, in Louisa county, Iowa. Thence, in a northwesterly direction, following the eastern branch known as the Cedar river, as far north as about opposite the mouth of the Wisconsin river. Thence east, in about the same line of latitude to Lake Michigan, following the Wisconsin river so far as it lies in this line, thus leaving out the northernmost counties of Iowa, and including the two lower tiers of counties of Wisconsin. Thence, southernly around the lower extremity of the lake, and taking in the northwestern corner of Indiana, as far south as the Kankakee river. If they extended at all into Michigan, it could only have been a little over the line, as advices from Kalamazoo, and from two witnesses in Benton Harbor, agree in certifying that no locusts were seen in those localities. Thence, taking our departure from about the point where the Kankakee river crosses the Indiana border, the locust line takes a southwesternly direction through Iroquois county, till it strikes the head waters of the Sangamon river, in the northwestern corner of Champaign county. From this point, the Sangamon river seems to have formed very nearly the southern border of the locust range. By looking upon a map it will be seen that this river takes, first, a southwesternly and then a westernly direction, till it reaches the vicinity of the city of Springfield, which seems to have been the southernmost limit of these insects. Thence, the locust line continues to follow the river, first northernly, through Menard county, to the northern boundary of said county, and then west on the dividing line between Cass and Mason counties, to its junction with the Illinois river. From this point there appears to have been a gap in the locust line until we reach the southern part of Peoria county, a little below the entrance of the Mackinaw river, in Tazewell county, into the Illinois, where the locusts were abundant. From the southern point of Peoria county the line strikes northwest, taking in the northeast corner of Fulton county, and continuing through Knox county on about a line with the city of Galesburg, where only a few locusts were seen. Thence north, to the eastern border of Mercer county, and thence west, through the middle of Mercer county, following, in the main, the course

of the Edwards river to its entrance into the Mississippi, nearly opposite the mouth of the Iowa river, which was the place of beginning.

The only gap in this outline, of any considerable extent, that I have heard of, is the one above referred to, between the Sangamon river on the south, and the Mackinaw river in Tazewell county, on the north—the average course of this last named river being about on a line with the southern point of Peoria county, and the intervening space embracing the whole of Mason county. This gap is the more remarkable at first sight, inasmuch as the bluffs on both sides of the Illinois river are well wooded, and would, therefore, seem to form a natural continuation of the locust range. The first explanation that occurred to me of this break in the line, was in the sandy nature of the soil in this locality. Mr. J. Cochrane, of Havana, Mason county, in his communications to me upon this subject, speaks of the sandy character of the soil, and subsequently, Mr. Stephen Tompkins, of Avon, Fulton county, who is an old resident of this county, and who has often traversed it in all directions, described to me more particularly the character of this section. He stated that from the southern point of Peoria county to Beardstown, six miles below the mouth of the Sangamon river, the soil is very sandy on the east side of the Illinois river, but less so on the west side. At Beardstown the soil changes, becoming more intermixed with loam, and it is a curious fact that a few locusts were seen at this place, though it lies somewhat below the locust line. The supposition was that the locust grubs do not find, in this sandy soil, the kind of subterranean vegetation upon which it is their nature to subsist. But the correctness of this explanation was disproved by subsequent correspondence with Mr. Cochrane, in which he stated that there was an abundant brood of locusts in Mason county a number of years ago, about the year 1859 or 1860—as nearly as he can recollect—and that the groves and thickets of what is known as the black-jack oak, were, in particular, badly cut up by them. Mr. Tompkins also spoke of a visitation of locusts in Fulton county, about ten years ago. Both these gentlemen, undoubtedly, refer to the brood of 1861. The records show that there was a brood of locusts in this year, which occupied a narrow strip of country, including the northern border of Missouri and the southern border of Iowa, and extending across the middle of the State of Illinois, in the line of McDonough, Fulton, Mason, and Champaign counties. So that it would seem that the true explanation of the absence of locusts in Mason county in the year 1871, is the pre-occupation of this territory by another and perhaps older brood.

It will have been observed that in giving the above locust range I have often referred to rivers as forming its boundaries. It will, of course, be understood that it is not the rivers themselves, but the wood which skirt their banks, which really constitutes the boundary.

It is not to be inferred that all places within this outline were equally infested by these insects. Every one who traveled through this extensive region during their active period must have remarked that the locusts were much more abundant in some places than in others, even where the supply of timber was equally abundant. I heard of several curious instances of their being abundant at one end of a long grove, and almost wanting at the other.

Neither must it be understood that no locusts were seen outside of this range. The locust-line is not a simple and straight one, but more or less zig-zag, being necessarily much governed by the presence or absence of the timber which constitutes the natural depository of the nsects' eggs. Stragglers have often been seen many miles out upon the prairie, having been driven, sometimes, by high winds, and possibly being impelled by an instinct to extend their borders.

I may here remark, in passing, that the Northern Illinois brood of locusts of 1871 meets and interlocks more or less with the Sothern Illinois brood of 1868, which also extended further east, into the State of Indiana. Champaign county, in Illinois, which lies on the dividing line, seems to belong more to the southern than the northern brood, inasmuch as but few locusts were seen in this county in 1871, and these mostly in the northwestern part, whilst all the southern half of the county was densely infested by them in 1868.

I take this opportunity to express my thanks to the many persons who have assisted me in this enquiry, and upon whose authority the above statements are made. I deem it just and proper to give the names of these individuals in their geographical order. Suel Foster, of Muscatine, Iowa; Charles W. Lillie, Independence, Iowa; J. L. Budd, Cedar Rapids, Iowa; Postmaster of Lansing, in Northeastern Iowa; Dr. John Conant, Prairie du Chien, Wisconsin; Morrow and Brother, Madison, Wisconsin; L. Camfield, Benton Harbor, Michigan; Judge David Turner, Crown Point, Indiana; J. B. Dodge, Warsaw, Indiana; Dr. J. H. Longbridge, Rensselaer, Indiana; P. D. Hammond, LaFayette, Indiana; B. N. McKinstry, Kankakee, Illinois; L. H. Fairchild, Danville, Illinois; J. R. Parks, Tolono, Illinois; E. Daggy, Tuscola, Illinois; Prof. Burrill and Dr. Howard, Champaign, Illinois; Charles S. Davis, Decatur, Illinois; Prof. J. B. Turner, Jacksonville,

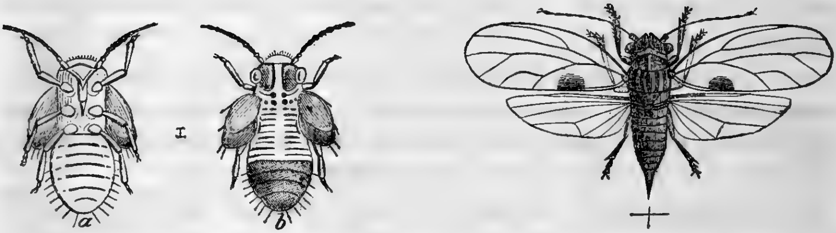
Illinois; J. T. McNeely, Petersburg, Menard county, Illinois; Dr. J. F. Snyder, Virginia, Cass county, Illinois; J. Cochrane, Havana, Mason county, Illinois; Postmaster of Canton, Fulton county, Illinois; Postmaster of Farmington, Fulton county, Illinois; Stephen Tompkins, Fulton county, Illinois; Dr. A. G. Humphrey, Galesburg, Illinois; Tyler McWhorter, Aledo, Mercer county, Illinois.

TREATMENT.

The Periodical Cicada cannot be considered, in a practical point of view, as an insect of very serious character. Even if the injury caused by them were more severe than it is, the long period which intervenes between their successive appearances, would reduce them to the rank of not more than a third class noxious insect. The damage done by them, as a general rule, amounts to nothing more than a pretty severe twig-pruning, which is out grown in a year or two, by trees of considerable size. But young nursery and orchard trees are often severely cut up by them, and sometimes killed outright.

All attempts to check or drive away the locusts after they have made their appearance, have proved futile. The only practical rule of any importance respecting them is, to avoid planting a nursery or young orchard upon cleared land, or in the vicinity of timber land, where it is known by experience, that these insects will make their appearance in a few years.

INSECTS INJURIOUS TO THE PEAR TREE.



Explanation.—Psylla Pyri—*a*, pupa, showing the under side; *b*, upper side of same

THE PEAR FLEA-LOUSE.

(*Psylla Pyri*, Linn ?)

Order of HOMOPTERA. Family of PSYLLIDÆ.

Whilst visiting the fruit farm of Mr. Parker Earle, of South Pass, on the first of June, my attention was called to the sickly condition of some of his young pear trees, apparently caused by a leakage of sap from the axils of the leaves; in some instances running down the branches and trunk to the ground.

Mr. Earle had examined his trees a number of times for the purpose of discovering the cause of this mischief, but on account, as it afterwards appeared, of the very small size and concealed position of the real culprit, he had failed to detect it. Upon turning my attention particularly to the points from which the flow of sap seemed to originate, and with the aid of a pocket lens, I discovered, imbedded in the axils of the leaf-stalks, and immersed in the exuding sap, from one to half a dozen minute, louse-like insects, which were evidently the cause of the injury. I afterwards captured a few of the mature or winged insects which furnished the clue to their name and character. They belong to the Homopterous Genus *Psylla* of Geoffroy, and are very similar to, if not identical with a species equally injurious to the pear tree in Europe, to which Linnaeus gave the name of *Chermes Pyri*.

Dr. Harris gives a short account of the damage produced, probably by the same species, in Massachusetts, between the years 1834 and 1838 inclusive, and speaks of one individual who lost several hundred pear trees from this cause. No record however has heretofore been made of its appearance in the Western States.

The following additional particulars in the habits of this insect were subsequently communicated to me by Mr. Earle, under date of July 10:

"I first observed the strange exudation of sap on the leaves of my pear trees about the middle of May, noticing it first upon the Duchess d'Angouleme variety. After a few days the injury seemed to extend to every leaf of every tree of that variety in the orchard, and to a less general extent, involving the Howell, Bartlett, and Lawrence varieties. The sap exuded most seriously from the axils of the leaves, but was found in globules, scattered over the surface of most of the leaves, slowly drying away to a sticky sirup. All growth was at once arrested, and the trees lost a portion of their leaves, amounting, in some cases, to more than a quarter of the foliage. The extent of their ravages was about as great at the time of your visit, on the first of June, as at any time thereafter. I saw no particular change for a week or so, when we had a heavy rain, after which they appeared less numerous. But whether the little pests were destroyed by the rain, or had just then reached the end of their destructive career, I am not able to say. The whole term of their visible depredations in my orchard was a little less than one month. I find that my neighbors suffered in the same manner and to about the same extent."

Many species of insects are found inhabiting the two continents, which are so similar to each other, that they have been denominated representative species. The increased facilities of communication are, every year, bringing new instances of this kind to the knowledge of entomologists, in which insects that have long been supposed to be peculiar to one country, are found repeated in the other, with no greater variation than species are known to undergo, in their own country, from a change of food, locality, and other circumstances. Whether these insects are really distinct species or modified descendants from a common origin, is one of those obstruse questions in natural history, which, with our present knowledge, we are, in many cases, unable to decide. But where the species in question are known to subsist upon the common fruit-trees or vegetables, and where their transportation can be easily explained, the best course would seem to be to assume their identity, unless the differences are important and of a decidedly organic character. One of these instances is furnished by the little insect now under consideration. From a comparison of the few specimens of the winged insect in my possession, with such descriptions of the European insect as I have access to, I should be led to regard them as different species; but a colored figure of the *Psylla pyri* of Europe, by the accurate hand of Mr. Westwood, communicated to me by Mr. Riley, resembles my

specimens so nearly in coloring, and so precisely in the venation of the wings, that I do not feel authorized in considering our insect as a distinct species, without further investigation.

I will briefly direct attention to those points in which the discrepancy seems to exist.

M. Kollar, a German author of good standing, describes the European insect as varying somewhat in its hues at different seasons of the year, but as having, when in its fullest maturity, the head and thorax of an orange or a crimson color, shaded with black in the male, the abdomen green, and the wings snow-white.

Our species is also of a deep orange-red color, but the thorax is not merely shaded, but distinctly striped with black, as shown in the annexed figure. The abdomen, at least in the dried specimen, is blackish-brown, and the wings are clear, and in no sense snow-white.

The common habit of the larvæ and pupæ of our species of nestling in the axils of the leaf-stalks, and thus escaping observation, I do not find mentioned in the history of the foreign species.

In consideration of the economic importance of this insect, and of the interesting position which it holds in a scientific point of view, it might be appropriately designated by the specific name of *americana*, if it should be decided to be a distinct species.

I will not occupy more space by a minute description of these insects, but refer the reader to the figures at the head of this chapter, which exhibit the insect in both its perfect and preparatory stages, greatly magnified.

It is proper to add, however, that my specimens of the winged insect not being sufficiently well preserved to be correctly figured, I have made use of a cut, taken from a specimen from Massachusetts, which is presumed to represent the same species.

INSECTS INJURIOUS TO THE PLUM.

THE SMALL BRONZE FLEA-BEETLE.

(*Haltica helxines.* Linn.)

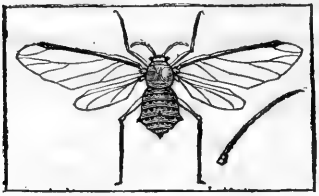
Order of COLEOPTERA. Family of CHRYSOMELIDÆ.

These pretty little beetles are found upon several kinds of fruit trees, early in the spring, eating roundish holes through the leaves, and sometimes destroying the petals or flower leaves.

They are only the tenth of an inch in length, and are of a coppery-brown or bronze color. In the Walsh Cabinet were specimens referred to this species, of a beautiful metallic green. Like others of their genus, they have very stout hind thighs which enable them to skip out of sight, when disturbed. From their appearance so early in the season, it is evident that like many other of the leaf-beetles, they hibernate in the perfect state.

They are seen upon the plum, the apple and the pear, and they seem to be partial to the tender foliage of the suckers which spring up around the base of the trunk. I have seen the foliage and the blossoms of the plum tree, in particular, so riddled by these insects as to attract notice from a distance, and to a sufficient extent to entitle this species to a place on the list of what may be called the minor noxious insects. My attention was first attracted to them in the latter part of April. On the 6th of May they were seen pairing, and before the middle of the month they had mostly disappeared, having, no doubt, laid their eggs and perished, as is the general course of insects after having provided for a future generation. I examined the infested trees several times in the course of the season, but failed to discover either the eggs or the larvæ of the insects. Should these insects become troublesome, they would have to be treated upon general principles; that is, the application to the tree of some of those substances which are known to be obnoxious to insects but harmless to vegetation, such as lime and whale-oil soap.

INSECTS INJURIOUS TO THE WILLOW.



THE SPOTTED WILLOW-APHIS.

(*Lachnus dentatus*, n. sp.)

Order of HOMOPTERA. Family of APHIDÆ.

Found in flocks, in October and November, on the under side of the branches of the gray willow. They were also found in smaller numbers on the trunks of small nursery apple trees, standing about a rod from the willows. When crushed, they stain the fingers with a thick reddish fluid.

Length, two-twelfths of an inch; expanse of the wings, six-tenths. Black; abdomen, dark ash-colored, with six transverse rows of black dots. Antennæ, filiform, as long as the head and thorax; two basal joints, short and stout, the third as long as the three terminal ones united; these three equal. Proboscis, greenish-yellow at base. Fore wings, with the usual stout sub-costal vein, and a very elongate stigma; three discoidal veins, (exclusive of the stigmatic vein,) much wider apart at their tips than at their bases; third vein, two-forked; hind wings with a sub-costal and two discoidal veins, the latter very closely approximate at base and divergent at tip. Thighs, dark honey-yellow, broadly tipt with black; tibiæ, dusky; reddish at the base.

The honey-tubes are sub-obsolete. The dots on the abdomen are very distinct, especially on the fully-grown, wingless individuals. In the intermediate rows, the dots are six in number, the two middle ones being smaller than the others. Just behind the middle of the abdomen, and occupying the place of the two middle dots in the fourth row, is a somewhat conspicuous black, conical protuberance, varying in size in different individuals, and sometimes considerably more prominent than it is represented in the figure.

This species belongs to the genus Lachnus, of Illiger, which differs from Aphis proper in the shortness of the antennæ, the seventh joint being rudimental or wanting, in the very short and almost obsolete honey tubes, and in the habit of the species of stationing themselves on the limbs of trees instead of the foliage.

I cannot find that this species has been described, and Prof. Uhler, of Baltimore, to whom I transmitted specimens, confirms this opinion. Dr. Harris describes a similar species found on the pig-nut hickory, but this is a much larger species and has but four rows of dots on the abdomen. The same author also describes a species found, like the present, on the limbs of the willow, and also resembling this in staining the fingers red, when crushed. But this is a smaller species and wholly destitute of the characteristic dots on the abdomen. Dr. Fitch also briefly describes a species found on the willow, under the specific name, *sallicelis*, which he refers to the genus Lachnus; but this is a still smaller species, and also, so far as we can judge from the description, without spots on the abdomen. From the similarity in habit of Dr. Harris' species just referred to, the suspicion arises whether that may not prove to be an abnormal variety of the present species. In that case Dr. Harris' species would stand as a variety of the present, inasmuch as the specific name of *Salicti*, given by him to that species, had been pre-occupied.

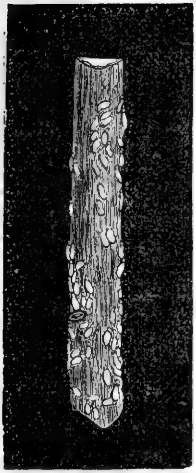
In selecting a name for this rather large and well-marked species, the term *salicis*—meaning, *of the willow*—which first suggested itself, was abandoned on account of its resemblance to several other terms, which mean essentially the same thing, and which have been already employed to designate other species of *Aphides*. The term *salicis*, itself, moreover, has been applied by Linnæus to a European species of the genus *Aphis*, and it is always desirable to avoid the repetition of the same specific term in naming the species of closely allied genera.

The term *punctatus*, referring to the dots on the abdomen, would seem to be very expressive, but it is not sufficiently characteristic. Prof. Uhler informs me that all the species of the genus *Lachnus* in his collection have the abdomen more or less spotted, so that this would seem to be a generic rather than a specific character. I therefore made use of the term *dentatus*, having reference to the conical or *tooth-like* process on the middle of the abdomen, and which, so far as I can learn, is peculiar to this species.

THE WILLOW BARK-LOUSE.

(*Mytilaspis salicis*, n. sp.)

Order of HOMOPTERA. Family of COCCIDÆ.



On the 8th of May, 1870, I received from Stark county, some twigs of the gray willow, densely infested with a pure white bark-louse scale, of about the same size as the Oyster-shell Bark-louse of the apple tree, being about one-tenth of an inch in length, but of a more regularly oblong, oval shape, and exhibiting but little of the curved or muscle shell form, which gives the scientific name to this genus of *Coccidæ*, and resembling more nearly, both in form and color, the scales of the bark-louse of the pine. They also resemble this last species in having blood-red eggs. The number of eggs under each scale averages about seventy-five, exceeding in this respect those of the apple tree, which usually have about forty-five or fifty, and still more those of the pine which rarely exceed thirty.

The eggs were just hatching at the time of their reception. The young, like the eggs, are deep-red. Indeed, it is the young within the transparent shell which gives to the egg its color. They exhibit, under the microscope, all the characters of the young of the other species of the genus *Mytilaspis*, being of an oval form, with short, tapering, divergent antennæ, and two anal filaments, as long as the body, but so fine at the extremity that the terminal third is only visible under a strong magnifier. The four digituli, or little finger-like processes with which the feet of this family of insects terminate, are very distinct in this species.

As the minute lice were just hatching at the time of their reception, I tried the experiment of tying one of the infested twigs to a branch of the gray willow, taking pains to adjust it so that the young insects could easily pass on to the tree. For some reason the experiment failed. I could never find the least trace of the insects upon the tree to which they were attached, and yet they were transferred to precisely the same kind of tree as that from which they were taken, and in not far from the same latitude. This failure may, therefore, teach us a useful caution against hasty conclusions in our experiments of transfering such minute insects from one kind of a tree to another. The failure of the experiment does not necessarily imply that the insects perish from incongeniality of food.

The twig from which the figure was taken, was much less densely infested with scales than some of the others.

INSECTS INJURIOUS TO GRAIN.

1 2

THE STALK-BORER.

(*Gortyna ritela.* Guenée.)

Order of LEPIDOPTERA. Family of NOCTUIDÆ.

The larva of this moth is a dark livid, naked worm, with a few imperfect whitish stripes, tapering a little at each end, and upwards of an inch and a quarter long, when fully grown. They have been known for a number of years, as doing considerable damage to various plants, by boring into their stalks. They have been most injurious to potatoes and tomatoes, and to garden flowers, especially dahlias and asters. It is closely allied to another species, the Gortyna zeæ of Harris, the larva of which bores into the stalk of the young plants of the Indian corn, causing them to wilt, turn yellow, and perish. There is no record of either species having been known to attack the small grains. An instance of their injury to the wheat plant, however, has come to my knowledge, the past season, of sufficient extent to warrant serious apprehensions that this most important crop may have another added to the already formidable list of its insect depredators.

On the 20th of June I received a number of these worms from Mr. A. E. Lansing, of Blooming-grove, Wisconsin, with the following note: "Inclosed in a tin box you will find three pieces of straw, containing worms, which are making a great destruction in the wheat fields. The like has never been seen in these parts. Some call it a weevil, but no one is able to tell what it is. I have seen it in all my neighbors' early wheat. One piece of two acres of very early wheat is entirely ruined. This is five miles east of Madison."

The worms were at this time less than half grown, but could be easily identified as the larvæ of the moth named at the head of this article.

It is a very important question whether these insects are likely to multiply and spread so as to become a serious enemy of the wheat crop, in the more northern latitudes. It is worthy of remark that these larvæ usually inhabit the larger and more succulent plants, and do not attain their full size, so as to be prepared to transform, until about the end of July. There is some reason to hope, therefore, that the wheat plant will not prove to be sufficiently succulent and long-lived to enable them to come to that perfect maturity, which is essential to the free propagation of the species.

We have given above figures of this insect in both its larva and winged states, to aid in their identification. If they should make their appearance another season, and especially if they appear to be spreading, it will be very desirable that those suffering by their depredations shall make notes of their times of appearance and disappearance, and other habits, so that we may be enabled to suggest some rational means of checking their increase.

THE CHINCH-BUG.

(*Micropus leucopterus*, Say.)

Order of HETEROPTERA. Family of LYGÆIDÆ.

Harris's Treatise, page 198. Fitch's 1st and 2d Reports, page 277. Riley's 2d Report, page 15. Shimer, in Proc. Phil. Acad. Sc., May, 1867.

The summer of 1871 has been chiefly remarkable in this State, in an entomological point of view, for the periodical appearance of the 17-year Cicada, and the excessive prevalence of the notorious Chinch-bug.

Some idea of the loss caused by the depredations of this last named insect, in this and the neighboring States, may be realized when we learn that over a belt of territory one hundred miles wide, commencing in the western part of Indiana, and extending more than four hundred miles west, embracing an area of more than forty thousand square miles, the great staple of spring wheat was reduced to not more than a quarter of an average crop, and in many places wholly destroyed; and that over the same territory barley was less than half a crop, and oats not more than three-quarters of their usual amount.

The center of this belt appears to have been a little north of the center of the State, being about on a line with the junction of Iowa and Missouri, and taking in a corresponding part of Southern Iowa and Nebraska and of Northern Missouri and Kansas. South of this belt winter wheat takes the place of spring wheat and barley, and the Chinch-bugs, though present in considerable numbers, ceased to commit any very serious damage. North of this belt, also, notwithstanding that spring wheat constitutes a leading crop, the bugs became gradually less numerous, and a tolerable crop of this grain was harvested. And yet all through Northern Illinois and the southern part of Wisconsin, these insects were numerous enough to damage the crop to some extent, and to excite the most serious apprehensions for the succeeding year.

In order to obtain as correct an idea as possible of the amount of loss sustained by the agriculturist from the depredations of this insect, the past year (1871), both in this and the other Northwestern States, I have made the following calculation, based upon the statistics of the Department of Agriculture, with a reasonable estimate of the proportional damage caused by this insect to those crops upon which they depredate. All such calculations must necessarily be only approximately correct, and very loose and extravagant conjectures have sometimes been indulged in upon the loss caused by Chinch-bugs in former seasons of their prevalence. It has been my intention to keep within reasonable bounds, and by giving the figures in the case I give others the opportunity to review my estimates.

Taking the returns to the Department of Agriculture, for the years 1869 and 1870, for our guide, we may assume the present annual yield of wheat, in the State of Illinois, to be 30,000,000 of bushels; of oats, 40,000,000; and of barley, 2,000,000.

The area seriously ravaged by these insects, comprised, as we have above stated, about the middle third of the State. This section would bear its full proportional third of the wheat and oats, and at least one-half of the barley raised in the whole State. This would give as the product of that part of the State ravaged by Chinch-bugs, 10,000,000 bushels of wheat, upwards of 13,300,000 bushels of oats, and 1,000,000 bushels of barley. The proportion of these crops destroyed by Chinch-bugs, we have put at three-quarters of the wheat, one-half of the barley, and one-quarter of the oats. This will give as the amounts actually destroyed by these insects, 7,500,000 bushels of wheat; 500,000 bushels of barley, and, in round numbers, 3,300,000 bushels of oats.

If we make a cash estimate of this loss, by putting the price of wheat at one dollar a bushel, barley at 50 cents, and oats at 25 cents, we shall have an aggregate loss of upwards of eight and a half millions of dollars in the central third of the State of Illinois.

In this estimate we have made no account of the injury done to corn throughout the State, nor of the damage to small grains north of the central belt. Here the calculation becomes much more indefinite, but I believe it will be generally admitted to be a low estimate if we add, for this purpose, one-quarter part to the above aggregate of loss. This will make the total loss caused by Chinch-bugs, in the State of Illinois, in the year 1871, upwards of ten and a half millions of dollars.

If we assume an equal amount of loss for the two States of Iowa and Missouri combined, and another equal amount for the four States of Indiana, Kansas, Nebraska and Wisconsin, we shall have a total loss in one year, in the Northwestern States, of upwards of 30,000,000 of dollars, from this one species of insect.

In consideration, therefore, of the enormous loss caused by the Chinch-bug in the past year, and the well-founded apprehensions for the year to come, every observation which can throw any light upon the history and treatment of this formidable insect, becomes of the greatest interest and importance. So much, however, has already been written upon the general history of this insect, that we shall confine ourselves, at the present time, to the practical treatment of the subject, especially in the light of the experiences of the past season.

The methods and agencies for the destruction of these insects, or for the prevention of their excessive multiplication, may be reduced to the following :

1st. Their natural enemies.

2d. The plan of anticipating their ravages by sowing grain so early, in the spring, as to get in advance of their depredations.

3d. The attempt to save a part of our crops by preventing the migration of the bugs from one field to another.

4th. The method of destroying them by burning corn stalks and other rubbish, in the fall of the year.

5th. The attempt to prevent their breeding, to any serious extent, by abstaining from the cultivation of those grains upon which they chiefly subsist.

FIRST.—THEIR NATURAL ENEMIES.

With respect to the destruction of Chinch-bugs by natural enemies, the testimony on record is extremely meagre and unsatisfactory. Lady-bugs are sometimes found in company with them under corn husks and in other sheltered situations, and this circumstance, taken in connection with the fact that these are predaceous insects, has led most of our writers upon practical entomology to enumerate them amongst the destroyers of Chinch-bugs, but I can not learn that any one has actually seen them devouring these nauseous insects.

The larvæ of the Lace-winged flies sometimes feed upon them, as has been proved by the observations of Dr. Shimer. But it is only occasionally that the Lace-wings are seen where Chinch-bugs abound, and they are nowhere numerous enough to make any perceptible impression upon their multitudinous hosts. It has been said that quails will eat them, but this seems to rest upon a few imperfectly attested statements, passed down from one to another, rather than upon actual and repeated observation. I do not wish to be understood as denying the truth of the statement; but if there is any reliable testimony upon this subject, it has escaped my search. At any rate, I believe, that for all practical purposes, any hope of essential aid from natural enemies, in the destruction of Chinch-bugs, may as well be thrown wholly out of the question.

SECOND.—THE PLAN OF SOWING GRAIN SO EARLY IN THE SPRING AS TO GET IN ADVANCE OF THEIR DEPREDATIONS.

The well-known fact that winter wheat generally matures before the young brood of Chinch-bugs makes its appearance, and thus escapes their ravages, naturally suggested the idea that the same end might be accomplished with respect to spring wheat, if the seed could be got into the ground very early in the spring. However plausible this supposition may appear, the experiences of the past season would seem to show that any reliance based upon it must prove, in a great measure, fallacious. Notwithstanding that the last spring was dry and favorable for the early sowing of grain, and notwithstanding that it is universally understood by farmers that the earlier wheat can be sown the better for the crop, and therefore it may be presumed that wheat was sown unusually early, yet the result could scarcely have been more disastrous. I am not prepared to say that nothing can be gained by this course, but in view of the experiences of the past season, I do not see how we

can place much reliance upon this method of escaping the ravages of the Chinch-bug.

In this connection we may advert to the plan of sowing certain stimulating substances, such as salt and lime, with the seed, for the purpose of hastening the growth and the ripening of the grain. It has also been supposed that a pretty heavy dressing with such materials might render the soil obnoxious to the bugs. I have known of attempts being made to protect corn from the bugs, by the application of salt and air-slacked lime, but without any visible effect, and it is not probable that any quantity of such substances which we could reasonably apply to the soil would be effective in preserving our crops from these insects. But in the other point of view, that of hastening the ripening of the grain and thus placing it in advance of the depredations of the bugs, this plan seems to me to be well worthy of trial. I was informed by a farmer living in Dixon, that he had tried sowing salt with his spring wheat, at the rate of one barrel to two and a half acres, and that upon the part of the field so treated, the crop was much larger than on the other portions, and ten or twelve days earlier. The effects of salt will differ, of course, to some extent, like all other applications, according to the nature and condition of the soil.

THIRD.—THE ATTEMPT TO SAVE A PART OF OUR CROPS BY PREVENTING THE MIGRATION OF THE BUGS FROM ONE FIELD TO ANOTHER.

It is well known that when the small grains become too mature and dry to afford nutriment to the Chinch-bugs, they migrate in vast numbers into the adjoining cornfields, and generally destroy from half a dozen to a dozen or more of the outer rows, and nothing but the great extent of these fields, at the West, and the exuberance of the plants, which, at this time, have nearly completed their growth, preserve the corn crop from the same destruction which has overtaken the smaller grains.

As this migration takes place before the young brood have acquired wings they necessarily travel on foot, and various attempts have been made to intercept their progress. The principal of these are a succession of furrows plowed across their path, and a barricade of fence-boards besmeared with coal tar or kerosene oil. The first plan, though but very partially successful, is so simple and easy of execution that it is always worthy of trial. I was informed by some of the farmers who practiced it the past season, that it very materially checked their progress for the first day or two, so long as the furrow was fresh and the

earth friable; but that a shower of rain or heavy dews for a succession of nights, so consolidated the earth that the insects could pass over.

The other plan is much more effective, but also much more troublesome and expensive. It consists of a barricade of fence-boards, placed end to end, and set edgewise into the ground, with the upper edge besmeared with some offensive substance, the one most commonly used being coal tar. This method has been extensively resorted to, the past season, in the central part of the State, and especially in the neighborhood of the Bloomington gas works, where the coal tar is extensively manufactured. I was informed by one of the proprietors of the gas-works that nearly one hundred and fifty barrels of tar had been purchased at that establishment for this purpose. I had an opportunity of seeing this method put in practice, on a large scale, on the farm of Mr. Joshua Sells, of Bloomington. At the time of my visit Mr. Sells had discarded the boards as an unnecessary trouble and expense, and had adopted the simpler and more expeditious plan of running a stream of tar, from the spout of an old tea-kettle directly upon the ground, along the exposed sides of his cornfields. He found that a gallon of tar would extend about ten rods, so that a two-gallon kettle, twice filled, would furnish a strip of tarred ground the whole length of a forty-rod cornfield. The tar had to be renewed every other day, and oftener in case of rain. The insects would crowd up to the line in such numbers, that in many places they would pile up from half an inch to an inch deep, and could be scraped up by the double handful.. But so long as the tar was kept fresh not a bug would cross it. They were not prevented from crossing by the adhesive nature of the tar, but by its repulsiveness. The bugs would not touch it. They were destroyed by conducting them into perpendicular holes, or by shoveling them in and burying them. The usual price of coal tar at the gas-works is about two dollars a barrel. This is the most effective means yet resorted to for intercepting the progress of these insects when in the act of moving from one field to another; but the trouble and expense of using it, especially at a distance from the places where the tar is manufactured, will probably prevent its ever being very generally practiced. The great deficiency of all such methods, as a remedy for the chinch-bug, is that, at best, they only protect that crop which is usually the least damaged by them.

FOURTH.—THE METHOD OF DESTROYING THE INSECTS BY BURNING CORN-STALKS AND OTHER RUBBISH IN WHICH THEY ARE SUPPOSED TO HIBERNATE.

We have just adverted to the fact that when the small grains fail the Chinch-bugs migrate into the corn, and that at this time they travel on foot and confine themselves mostly to the outer rows. But shortly after this, the young bugs acquire wings and then spread themselves over the field in large flocks. It is a question of considerable importance, and one to which but little attention has been paid, whether these insects materially damage the corn crop after this general scattering of themselves, in the latter part of summer. From the circumstances of the case, this question does not admit of a very easy solution. The fact that insects require comparatively little nutriment after they have attained their winged and mature state, taken in connection with the vast extent and luxuriance of the western cornfields, and with the additional consideration that the crop, being at this time considerably advanced, the loss would be only comparative, and therefore not easily discriminated; all this tends to involve the subject in much uncertainty.

Mr. George W. Patten, of Delavan, in Tazewell county, at whose house I visited in the hight of the Chinch-bug season, actively co-operated with me in the determination of this and other matters appertaining to these destructive insects. Mr. Patten took the pains to visit many of the farmers in his own and the neighboring counties, all of which were badly infested, for the purpose of making inquiries upon this point. He found it to be the general opinion that the bugs had damaged the crop very sensibly. As the whole State has suffered severely the past season, for the want of rain, there was the additional difficulty in this case, of distinguishing between the effects of the drouth and that caused by the bugs. The insects themselves, however, furnished a key to the solution of this difficulty, by virtue of their gregarious habits. It appears that they do not scatter themselves indiscriminately over the field, but that they move in large flocks, not unlike their fellow depredators—the blackbirds. Accordingly the cornfields are found to be damaged in patches, and it was thought to a sufficient extent to materially diminish the crop.

This general diffusion of the chinch bugs over the cornfields after midsummer, taken in connection with the common observation that they remain there till late in the fall, has naturally suggested the ex-

pediency of gathering the stalks together and burning them, after the corn has been harvested, with the view of destroying the bugs. It has also been advised, in order to make the remedy more sure, to burn the dead grass and other rubbish which accumulates around the borders of fields and fences. My own observations have led me to the conclusion that this remedy, also, in the way that it would be likely to be generally put in practice, can be of but little avail. Upon examining an infested cornfield late in October, I found that the bugs had left the upper part of the stalks and had collected about the one or two lowermost joints, under the sheaths of which they were congregated. They had gone thither, partly perhaps to avoid exposure to the cold winds of approaching winter, but chiefly, no doubt, for the sake of the nutriment which they could still extract from the lower joints of the stalks after the upper ones had become dead and dry. Upon visiting the same field a month later (Nov. 22d), after winter had virtually set in, the mercury standing 15° above zero, and the ground whitened with snow, after cattle had had the range of the field, very few bugs could be found. A few were found in deep cracks in the stalks, and a few were lying torpid upon the ground close to the roots of the corn. Upon digging up a number of hills no bugs could be found beneath the surface. Where the great majority of them had gone was not apparent. It is known that some of these insects hibernate under boards and flat stones, lying loosely upon the ground, and similar situations. Dr. Shimer found many of them under the fallen leaves of apple trees, but nearly half of these were dead. I have heard of their being seen flying in flocks, towards the woods, late in the fall. I cannot vouch for the truth of this, but I found them, this fall, in small numbers, under the loose bark of prostrate logs, in the edge of the woods, half a mile from any tillage land. I also found them congregated on the under side of some flat stones, lying upon stubble land. Within a few rods from them was a ravine filled with long dead grass, but I could find no bugs amongst the grass. It is proper to say, however, that this last was not a badly infested locality.

With the view of obtaining further observations upon this part of the subject, still later in the season, and especially in the badly infested district, I wrote to my friend Mr. Patten, whose assistance I have above been happy to acknowledge, and requested him to examine some of the cornfields in his vicinity. From Mr. Patten's reply, under date of December 20, I extract the following valuable observations:

" Since the receipt of your letter, I have at different times examined

corn stalks with a view to finding Chinch-bugs, but have not succeeded in finding a live one. I have a piece of ground sown to fall wheat, from which I had carried what few stalks of corn the bugs had left standing, and had thrown them in heaps along the edges of the field. These heaps I have been examining, and have always found large numbers of dead bugs, but no live ones. To-day it occurred to me that perhaps by bringing them into a room of proper temperature, they might shows signs of life; but after giving them a fair test, I have been unable to bring any to life. In all shocked corn that was put in shock before the frost killed the corn, I find large numbers of dead bugs, from the ear down. In later cut corn they do not seem to be so numerous. In the stalk fields I find very few bugs, either dead or alive. To-day I chopped up stalks by the roots, examining each sheath, from the ground up; then opened the stalks, both sound and and fractured ones, but found nothing that could be recognized as ever having been a Chinch-bug. That the bugs disappeared from their usual haunts upon the approach of severe cold weather, I am fully satisfied, but where they now are I have failed to ascertain. The first thought is that they have gone below the surface of the ground; but when we consider that our cold weather came so suddenly upon us that the first night the ground was frozen to the depth of three or four inches, it hardly seems possible that the Chinch-bugs could have penetrated it."

Mr. Patten made the following curious observation bearing upon the hibernation of these insects:

"About the time of our first frosts, while gathering hazel-nuts in the timber, I observed that in nearly every instance where a nut had been bored into by an insect or grub, from one to four Chinch-bugs had found their way into the nut. Whether they were there for winter quarters, or were feeding upon the partly consumed nut, was a question which I could not solve."

Mr. Patten concludes his letter with the following practical remark: "As to burning the stalks with a view to destroying the Chinch-bugs, I have but little faith in it. Could the stalks be burned before excessive cold weather sets in, very probably a large portion of the bugs could be destroyed, but by the time the corn can be harvested, and the stalks are dry enough to burn, the Chinch-bugs have taken to their legs or wings, and left for parts unknown."

What strikes us as remarkable in these statements of Mr. Patten is that all the Chinch-bugs which he discovered appear to have been dead. The question arises, did they die a natural or an unnatural death? Had

they arrived at the natural term of their lives, or were they killed by the sudden accession of cold weather, or by some other and unknown cause? As many of these insects were found in tolerably well protected situations, that is, under the sheaths of corn stalks which had been laid in piles, it does not seem probable that they could have been killed by the first cold snap of winter. The most plausible explanation of the case that I can give, is, that these dead insects were the old bugs of the former broods which had arrived at the end of their natural lives, whilst the instincts of the new brood, which are to perpetuate the race in the succeeding year, had led them to seek out more secure and permanent retreats.

From all this we conclude that late in the fall, and when winter is about to set in, Chinch-bugs, like most other insects, seek secure and hidden retreats where they will not be exposed to the snows of winter, nor to the cold rains of the late fall and spring, and therefore that the burning of corn stalks or other loose rubbish, late in the fall, will destroy but a very small proportion of them. The only way to accomplish this end, to any considerable extent, would be to husk the corn as early as possible, and then cut off the stalks close to the ground, and burn them. But even here it is very questionable whether the bugs would not leave the stalks before they were dry enough to burn. But in any event, the plan is scarcely available in actual practice. In the first place, most farmers depend upon their stalks for fall feed for their cattle; and if a farmer should conclude to sacrifice his stalks for this purpose, it would insure him no immunity from the inroads of the insects in the spring, from surrounding localities.

It may seem to be poor encouragement to show that the plans and preventives upon which we have been taught chiefly to rely, for checking the ravages of this formidable insect, are of so little real efficacy. But it is best to know the truth, and to see the evil in its true proportions. The first step to take, in meeting a real danger, is to divest ourselves of all false securities.

FIFTH.—THE PREVENTION OF THEIR BREEDING TO ANY SERIOUS EXTENT, BY ABSTAINING FROM THE CULTIVATION OF THOSE GRAINS UPON WHICH THEY CHIEFLY SUBSIST.

If then our supposed remedies for the Chinch-bug prove to be in a great measure fallacious; if experience shows that we cannot get our grain into the ground so early but that the bugs will be even with us; if plowed furrows and tarred barricades can only be resorted to when most of the mischief has been done; and if these insects hide them-

selves so securely, in the winter, that burning cornstalks and other rubbish can destroy, at best, but a very small proportion of them; and, finally, if their natural enemies are so few as to make no perceptible impression upon their countless hosts; then we are driven to inquire, with the more earnestness, whether we can take a step in advance of all these imperfect palliatives, and absolutely prevent the breeding of these noxious insects, to any serious extent, by abstaining from the cultivation of those crops which are most congenial to their nature. It may seem a hard alternative to give up the raising of some of our most valuable crops, at the behest of these nauseous *Hemiptera*, but a hard remedy is better than no remedy. It is better to save your labor and your seed, than to lose seed and labor and harvest likewise.

What then does experience teach us with regard to the breeding habits of these insects, and the plants upon which they mostly subsist?

When the warmth of spring has become sufficiently confirmed to penetrate the hidden recesses where insects hibernate, many different species which have wintered over, in the winged state, are seen emerging from their retreats, and launching out upon the vernal air, apparently rejoicing in their new lease of active existence. Amongst these, in the localities where they prevail, the Chinch-bugs are to be seen, flying in dense flocks, in search of the plants at the roots of which it is their instinct to deposit their eggs. Mr. Sells, of Bloomington, informed me that whilst plowing, about the first of May, his clothing and his horses were thickly sprinkled over with them, and that the horses were seriously annoyed in breathing by the bugs flying into their nostrils. These insects deposit their eggs at the roots of our cultivated cereals, and some of the grasses which most nearly resemble them. As the Chinch-bug is a native insect it must have subsisted originally upon the native grasses, before the cultivated cereals were introduced. The Chinch-bug was then a rare insect, only occasionally met with by collectors. Mr. Thomas Say, who spent twenty years in collecting and describing insects, in many parts of the United States and their Territories, first described the Chinch-bug, from a single specimen, and the only one which he had ever seen, and which was captured in the eastern part of Virginia. But there is no difficulty in getting specimens now. We have, ourselves, been the means of their excessive multiplication, by furnishing them with a superabundance of congenial food in the shape of our cultivated grains.

But the question now before us is, upon which of these grains do they thrive best, and will they thrive sufficiently upon all of them to

multiply to a serious extent, or are they restricted in their food-plants to such a degree that we have it in our power to get rid of them, at any time, by abandoning the cultivation of some one or more of these grains.

It seems remarkable that these insects should make a selection between plants so similar, both in nature and appearance, as are the several species of what are known as the small grains. Yet abundant experience has taught us that they do make a very decided selection. It is known that they always give a strong preference to spring wheat and barley, where these are at hand. Where these two grains are not available, they will oviposit upon either of the others, and perhaps to about an equal extent. We know this from the fact that all of these grains are sometimes considerably injured, where Chinch-bugs abound, and the chief reason, probably, why winter wheat does not suffer as much as spring wheat, is that this crop gets nearly matured before the new brood of bugs makes its appearance; and accordingly, we sometimes see late pieces of winter wheat almost as much damaged by them as the spring wheat. But the main question is, whether, if no spring wheat or barley be raised, the Chinch-bugs will continue to thrive and multiply to excess upon any other kinds of grain. The general opinion is that they will not. And yet a sufficient number of exceptional cases occur to throw some doubt upon the matter, and to induce some farmers to hold the opposite opinion. Chinch-bugs are, in some years, found in considerable numbers in the southern part of this State, where the winter grains exclusively are raised. A number of cases, also, like the following, have come to my knowledge. Mr. D. Veatch, of Livingston county, stated to me that winter wheat, oats and corn, were all seriously damaged in his neighborhood, though but little spring wheat was raised; and on his own farm, a field of thirty six acres of oats was not worth harvesting, though no spring wheat had been raised in its vicinity for the last five years. And a somewhat similar case was related to me by a Mr. Vail, of Tazewell county. More definite testimony is needed upon this subject. My opinion, from my present knowledge, is that such cases are rare and exceptional, and perhaps could be easily explained if we knew all the circumstances.

From the foregoing observations we draw the following practical conclusions:

1st. That it is useless to attempt to raise spring wheat or barley where Chinch-bugs have been present in any considerable numbers the

preceding year, unless we have reason to believe that they have been killed off by heavy rains in the breeding season.

2d. That in case the seasons should continue to be favorable to the propagation of the Chinch-bug, we always have it in our power to get rid of these pests by the abandonment of these two kinds of grain, for one or two years. But to make this course effective, there must be a concert of action by farmers over a considerable section of country.

3d. That the presence of Chinch-bugs the preceding year will not prevent the raising of corn or any of the winter grains.

4th. With regard to oats, the testimony thus far is that if this grain be sown where Chinch-bugs abound, and especially if it be sown exclusively, it will be damaged to a greater or less extent the first year, but that the bugs probably will not continue to breed in it to any great extent in succeeding years.

OTHER PROPOSED REMEDIES.

It may be proper, before closing, to advert briefly to a few of the more plausible of the other remedies for the Chinch-bug, which have been suggested.

It has been proposed to burn over the infested and ruined grain fields just before the time for the bugs to leave them, with the view of destroying the bugs and thus preventing their migration into the corn. This is a good suggestion, provided the grain is dry enough to burn before the bugs leave it; and also provided it will burn low enough to kill the bugs, which in this case would all drop to the ground. The plan would be most likely to succeed by the aid of dry straw, and favorable conditions of wind and drouth.

Another plan which has been proposed, is to sow a small proportion of winter rye (one bushel to twelve), with the spring wheat, with the expectation that the bugs would feed upon the green rye near the ground, whilst the more rapidly growing wheat would rise above it and come to maturity. This suggestion is founded upon the mistaken notion that Chinch-bugs feed upon the green blades of the grain, whereas they imbibe their nutriment, first from the roots, and afterwards from the lower joints of the stalk.

The well attested fact that Chinch-bugs are checked in their operations by rain, induced Dr. Fitch to advise the sprinkling of wheat fields—or at least those parts of them where the bugs first make their appearance—with water, by means of a garden engine, or some other contrivance. This would be an interesting experiment where the field is very small

and the supply of water abundant; but we presume the Doctor would hardly recommend this plan as practicable on the forty thousand square miles of territory overrun this year by Chinch-bugs, at the West.

All attempts to check the depredations of Chinch-bugs, by throwing offensive substances upon them, such as tarred saw-dust, salt or lime, have proved to be labor lost. The recommendation of the salt application had the run of the newspapers the past season. Both this and the air-slaked lime were thoroughly tried by Mr. Sells, of Bloomington, without making any perceptible impression upon the bugs.

DESTRUCTION OF CHINCH-BUGS BY NATURAL AGENCIES.

This article would be incomplete without a brief reference to those natural agencies by which this destructive insect is kept in check. Unlike many of our noxious insects, such as the Plum-curculio and the Codling moth, which are permanent fixtures, the Chinch-bug seems to be subject to an irregular kind of periodicity, the causes of which are not fully understood. We have stated above that we have no reason to expect any efficient aid in the extermination of Chinch-bugs from their natural enemies. It is far otherwise with adverse climatic influences. We have already had occasion to refer to the important fact in the history of this insect, which has been established by repeated observation, that cold rains, or a succession of heavy showers, especially in the month of June, when the insects are small and immature, are fatal to them; and, therefore, that no fears of Chinch-bugs need be entertained for a number of years succeeding a summer of this character. It is an unsettled question whether there are any other adverse influences by which the destruction of these insects, upon a large scale, is effected. Are they ever destroyed by the severity of winter, as well as by the rains of summer?

In the observations made upon these insects, in their winter quarters, by Dr. H. Shimer, in the winter and early spring of 1864–5, it appeared that all the bugs which had been overtaken by winter in exposed situations, especially if above the snow line, were found to be dead. Even of those which had found more secure retreats, under sticks of wood lying upon the ground, and under the fallen leaves of apple trees, from one-half to three-quarters were found to be dead in the spring.

The observations of Mr. G. W. Patten, above recorded, were of the same character, but still more decisive. All the bugs found by him in the month of December—although many of them were in tolerably well protected situations, under the sheaths of corn-stalks which had been

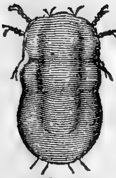
thrown in piles, were apparently dead, and that most, if not all of them, were really dead, and not merely torpid from cold, was proved by his experiments of bringing them into a warm room, and failing to resuscitate them. Now, the question is, what had caused the destruction of this large proportion of these insects? Were these the old bugs which had lived through the preceding winter, and which were now dying off—having fulfilled the ends of their existence? The analogy of insects, in general, would lead us to believe that the bugs of the former year perish much earlier in the season, soon after having deposited their eggs, and, therefore, that these were the bugs of the present season. We have not at present the requisite knowledge to discuss this matter satisfactorily. We only refer to it as an interesting field for future inquiries. Perhaps the key to the whole question will be found in the fact that the Chinch-bug is more a southern than a northern insect. Their ravages were recorded in Virginia and North Carolina many years before they made their way into these more northern sections. It would seem highly probable, therefore, that our northern winters must be incongenial to their natures, and often fatal to them. If this be so, we may expect that after a very cold winter, or even one of ordinary severity, but where there has been a scarcity of snow, the Chinch-bugs will have been so far destroyed as to be harmless for a number of succeeding years. And yet, the general fact that Chinch-bugs do survive our northern winters to a ruinous extent, is too patent to permit us to base our conduct upon any such speculations as the above, unless the truth of them shall be confirmed by future observation. The experience of the next year will be very interesting, in this point of view, more especially as the past summer has been a very dry one over a great part of the western country; and, therefore, if Chinch-bugs prove not to be destructively numerous next year, we shall be forced to account for their destruction by the operation of some other cause than the summer rains, to which their sudden disappearance, in former years, has been exclusively attributed.

USEFUL PARASITES.

THE GRASSHOPPER PARASITE.

(*Atoma gryllaria*, n. sp.)

Class of ARACHNIDA. Family of ACARIDÆ.



During a visit at the residence of Mr. O. B. Galusha, at Morris, on the 26th of June, he called my attention to a vermilion-red parasite, which he had observed for a number of years, and which were attached to the underside of the wings of grasshoppers. Mr. Galusha had previously spoken to me of these parasites, but I had not before had an opportunity to investigate them. Three years ago the grasshoppers prevailed excessively in this section of country, and were very destructive to many kinds of vegetation. Since then they have been much less numerous, and the diminution of their numbers has been attributed to the operation of these parasites, which seem greatly to weaken their victim without directly destroying it. The grasshoppers, the present season, are not very abundant, and did not appear to be much infested with parasites, though most of the fully-grown ones which we examined, had a few parasites attached to their wings. Subsequently, I examined grasshoppers in my own neighborhood, and found them equally, and some of them more severely infested. Upon the wings of one of them I counted thirty of these parasites. Most of them had attained a pretty uniform size, being about one-thirtieth of an inch in length, but easily visible on account of their intensely red color, giving them the appearance of little bits of sealing-wax, or coral.

They are of an oblong, oval form, moderately convex and having an uneven surface, produced by four shallow depressions on the upper side, the two larger near the middle, and the others behind them. The body has also two slight constrictions, giving it the appearance of being divided into three segments; but the impressions are superficial and only visible at the sides. The whole surface is finely striate, under the

microscope, the striæ running in a waving transverse direction. The mouth-organs appear to be reduced to their minimum of development. The only part visible, externally, is a minute papilla, on each side of which are two bristles, the inner of which is stouter, tapering to an acute point, and curved inwards, or towards its fellow of the opposite side. They differ from the majority of acarides in having but six legs, and these, being of but little use in so stationary a creature, are short and slender, projecting but little beyond the outline of the body. They are six-jointed, garnished with short stiff bristles, and terminate in two slender curved hooks. The anterior and middle legs are closely approximate and situated near the anterior extremity of the body; the posterior are set a little nearer to each other, and a little in advance of the middle of the body, being inserted at the posterior part of the anterior division or lobe. Four hairs project from the posterior extremity of the body.

These parasites are found on the under side of the basal half of the inferior or true wings, and adhere with such tenacity that it is difficult to scrape them off with the point of a penknife. They appear to adhere by their mouths and not by their claws.

The acari of this country have been but little studied, and scarcely anything has been done in the way of classifying them, or reducing them to their proper genera. The present species appears to belong to the division of *Trombidia hexapoda*, of Hermann, and to the genus *Atoma**, of Latrielle, chiefly characterized by the imperfect development of the oral organs.

The species of grasshopper which these parasites were found infesting at Mr. Galusha's, was the common red-legged grasshopper (*Caloptenus femur-rubrum*, of De Geer). They are stated in the American Entomologist to have been also found on the allied species so destructive west of the Mississippi river, and called by Prof. Uhler and Mr. Walsh, the *Caloptenus spretus*. The grasshopper upon which I found them so numerous, in my own neighborhood, was also a common but much larger species, the specific name of which I neglected to determine. It is probable, therefore, that they will be found infesting many different species of grasshoppers, and I have accordingly appropriated to them the specific name *gryllaria*, indicative of this tribe of insects.

* This is the generic term applied to these mites in the "Régne Animal." The word *Astoma*, meaning *mouthless*, would have been more characteristic, and might be supposed to have been the word intended, were it not that this latter term is appropriated, in the same work, to a genus of radiate animals in the class Acalepha.

NOTES OF THE SEASON.

THE LESSER APPLE LEAF-FOLDER.

(*Tortrix malivorana*, LeB.)

A brief account of this insect was given by the writer in his first annual Report. We refer to the subject now merely to add that the apprehensions which were naturally entertained of its increase and diffusion, have not been realized in the experience of the present year. Whether it be that they have been destroyed by natural enemies, or what seems more probable, in the absence of any known enemies of this kind, that they are very susceptible to the vicissitudes of the weather, it is a gratifying fact that the hosts of last year have entailed a very scanty progeny upon the present. I visited Mr. Wier's place this season, at about the time of my last year's observations, and though there were marks of damage by the early spring brood, the second brood seemed, for some reason, to have proved abortive. I could find but few specimens, and the nursery trees had made a good growth and presented none of the blasted aspect which they exhibited the previous year.

OYSTER SHELL BARK-LOUSE.

(*Mytilaspis conchiformis.*)

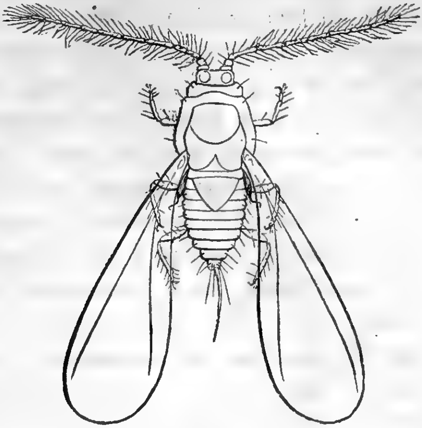
In treating of the remedies for the Apple Bark-louse, in the author's first Report, reference was made to the various applications which have been used for the purpose of destroying the eggs under the scales, it being very desirable that some such remedy shall be found, inasmuch as it can be applied in the early spring, when the farmer is more at leisure, and when the foliage, being yet in the bud, is not exposed to injury.

It was further remarked that experience had shown that very strong applications, such as undiluted soft soap, failed to destroy the vitality of the eggs under their protecting shield; but that simply greasing them over was fatal to them, probably by closing the pores and thus excluding the air. The question then naturally arose whether greasy applications would be injurious to the tree, and it appeared that the published testimony upon this subject is quite conflicting.

At the time of writing that article the season had gone by for experimenting in this matter; but in the spring which has since intervened (1871), I performed the following experiments for the purpose of further testing this point.

On the 30th of March, the buds not having yet expanded, I selected six thrifty five-year-old apple trees, of three different varieties, and applied to two of them simple lard, greasing over every part of the trees, trunk, branches and twigs. To two others kerosene oil was applied in the same manner. To the other two linseed oil was applied; but in this case, to vary the experiment, the terminal twigs were omitted. None of these trees were eventually damaged by the applications. Upon those to which the lard and the linseed oil were applied, no effect was perceived. They leafed out as early and looked as well as other trees standing beside them. The kerosene, as might have been anticipated, acted more severely. It killed or seriously damaged all the first buds, and the trees were several weeks later in leafing out than the others, but at an examination of them on the fifth of July, no difference could be seen in the quantity or healthiness of the foliage, from that on the other trees. One effect of the kerosene is deserving of notice. The check thus given to one of these trees had an effect similar to girdling or root-pruning, namely: that of throwing it into premature bearing—this tree producing an apple though still standing in the nursery row.

In further illustration of the effect of greasy application to apple-trees, I will add that Mr. James Crotty, an intelligent Irishman, in whose nursery the above experiments were performed, stated to me that when he lived in Ireland it was a common practice to annoint with linseed oil apple-trees large enough to bear, but which were growing too much to wood. The whole tree was annointed except the smallest twigs and fruit-spurs. The effect was to check the growth of the tree and put it into a bearing condition. The operation was not supposed to permanently injure the trees.



THE PINE LEAF SCALE-INSECT.

(*Mytilaspis Pinifolii*, Fitch.)

The natural history of this insect was given at some length in the author's first report. As it belongs to the family of Bark-lice (*Coccidæ*), but is in this case stationed upon the leaf, I distinguished it from its congeners by the English title of the White Pine Leaf-louse. But as the term Leaf-louse is usually restricted by entomologists to the various species of Aphides, I have here restored Dr. Fitch's name, which is free from this ambiguity.

My object in referring to this insect again is, to fill out a part of its history which my observations last year were made too late to determine. I refer to the time of hatching of the first or spring brood. In the former report, judging from what was known and from the analogy of allied species, I stated that the spring brood would probably be found to hatch in the month of May. The observations of the last spring show this conjecture to have been correct. It appears from my note book that the eggs were generally found hatched on the 25th of May, but not so early as the 10th, in my own locality or the latitude of Chicago. Happening to be at South Pass, in the southern part of the State, on the last of May, I found the new scales about half grown, so that it appears that the hatching of the first or spring brood of this species corresponds very closely with that of the first and only brood of the allied Bark-louse of the apple-tree.

The coccus of the pine, like that of the apple-tree, and I might add, also, like several species of the allied aphides, is first found on the lowest branches of the infested trees. This suggests the idea of cutting

—6

off and burning these branches, as one important step in eradicating the insects. A handsome Scotch pine in one of my neighbor's yard, upon which I made many of my observations, has been treated in this way, and the Lady-bugs having been busy at work upon the remaining branches, the tree is now almost free from its destructive parasites.

Owing to the absence of the author at the time of the printing of the second edition of the first report, the highly magnified figure of the male of this species, which was there referred to, was omitted. I have therefore had it prefixed to the present notice. In order to show clearly the characters of this insect, which is of much scientific interest, it has been drawn very greatly magnified. The insect itself is very minute, being only about one fiftieth of an inch in length.

THE COLORADO POTATO-BEETLE.

(*Doryphora, 10-lineata*, Say.)

Supplementary to the Author's article upon this Insect in his First Report.

The experiences of the past season, with regard to this comparatively new but now widely known noxious insect, have been remarkable, and not satisfactorily explained. It was the general report, especially in the northern parts of Illinois and Indiana and the southern parts of Wisconsin and Michigan, that these insects made their appearance in the spring in greater numbers than ever before, and it was the general impression that the potato crop was doomed to destruction. As the season progressed the reports became more favorable, and the result has been that a tolerable crop of potatoes has been harvested, notwithstanding that it also had to contend with drouth as well as insects, in the latter part of the season. Any one may obtain sufficient testimony to the accuracy of this statement, by reading the unfavorable reports of the National Department of Agriculture, for the months of May and June, and comparing them with the favorable and hopeful accounts of this crop in the same series of reports for the month of July. This favorable change was attributed partly to persistent hand-picking and the free use of Paris-green, and partly to the increased numbers of the natural enemies of the Potato-bug, especially the Armed Soldier-bug (*Arma spinosa*), which destroys the Potato-bugs mostly whilst in the immature state, by puncturing them and extracting their juices, and the Many-spotted Lady-bug (*Hippodamia maculata*), which checks

their increase by devouring their eggs. But there have been reports, from many localities, of a diminution in the numbers and destructiveness of these insects beyond what these agencies would account for. It was a common remark, after the season was somewhat advanced, that the Potato-bugs were not nearly so bad this year as they were the last. In the Agricultural Reports for July were such items as the following:

"Lapeer county, Michigan.—The potato crop looks fair. The old bugs have nearly disappeared; the young ones may yet do some damage."

"Green Lake county, Wisconsin.—Bugs leaving. They have left a few eggs and some young bugs, but the latter are doing no harm. The crop looks well."

"Howard county, Indiana.—The Colorado-bug has almost disappeared."

"Benton county, Minnesota.—Colorado-bug disappearing. Old ones have about all gone; the young ones do not seem to thrive as in previous years."

Now, these may have been exceptional cases, or rather exceptionally strong cases; but taken together and in connection with other observations, which we have not here space to record, they seem to intimate pretty clearly that the Colorado-beetle is not exempt from the operation of those general and imperfectly known laws or conditions which are known to affect other insects, and which cause them to be comparatively rare one year and abundant another. A curious paralellism may be traced between the inroads of noxious insects and the prevalence of epidemic diseases, both being much more virulent and destructive in the earlier than in the later periods of their prevalence.

If this view is correct, it gives us reason to hope that though this destructive insect may not become wholly exterminated, it may nevertheless cease, in a few years, to be the terrible scourge that it has been for the five or six years last past.

As the Colorado-beetle originated from the far West, and has been steadily progressing eastward, the question has been anxiously asked by agriculturists, whether, in proportion as these insects overrun new territory, they will subside in the sections first attacked. The experiences of the past year go far to answer this question in the affirmative. Whilst the most disastrous reports have come from the more recently invaded States of Indiana and Michigan, the State of Iowa, which these insects ravaged for a year or two before they crossed the Mississippi

River, has been comparatively exempt, and the potato crop has been good, especially in the northern counties.

With respect to that popular remedy, the Paris-green, there is with many people a natural disinclination to the free use of so virulent a poison. This repugnance is founded not only upon its dangerous qualities, but also upon a lurking suspicion that its constant use is injurious, though not absolutely poisonous, to the potato. It is more probable that the imperfect quality of the potatoes, where much Paris-green has been used, is owing to the general damage of the plants, both by the insects and the remedy, rather than to any specific poisonous influence of the latter. But, be this as it may, it is undoubtedly true that potatoes which are known to have been raised without any contact of the plants with Paris-green, will command a more ready sale in the market than those which have been produced by its use.

The natural wish to raise potatoes without the use of poisonous applications, has led to a variety of experiments for the purpose of capturing and destroying potato-bugs by machinery. One of these machines, which has the important merits of simplicity and cheapness, has been gotten up, the past season, by Mr. George Squires, a successful farmer, residing near Aurora, in Kane county. Having had an opportunity to see this machine, and to converse with Mr. Squires concerning its use, I will briefly describe it. It may be stated, in general terms, to be an oblong shallow box, which is drawn by a horse between the rows, whilst the bugs are knocked into it by brush or paddles working at the sides. It is constructed something in this wise: First, a plain board platform or drag is made, six feet long, and two and a half feet wide, coming within three inches of the vines on either side, the potatoes being planted in rows three feet apart. Upon this are set four posts, one at each of the hind corners, and the other two four feet in advance of them. To these posts the side and end boards of the box are nailed, the sides being four inches and the ends about eight inches high. This leaves two feet in front of the box which serves as a platform on which the driver stands. The posts may be made of two-by-four scantling, though it is not necessary to have them so thick. They are two feet high, and set a little flaring so as to bring their tops over the middle of the rows. They are set with their flat sides facing fore and aft, or towards their fellows on the same side. Two inches from the top an augur hole, an inch and a half in diameter, is bored. From the top of one post to that of the other, on the same side, extends the revolving bar, about three inches in diameter, its ends being narrowed

so as to enter the holes in the posts. Through this bar, a few inches from each end, an oblong square hole, or mortise, is cut, through which the arms pass, to the ends of which the flapper is attached, as seen in the figure. The flapper is a piece of thin board, a piece of siding for example, which is nailed to the ends of the arms. The arms are so arranged as to slide by each other in the mortise, and in this way the flapper can be raised or lowered according to the hight of the vines. The bars, with their flappers, are made to revolve by a crank attached to the forward end of the near, or left hand bar, and is turned by the driver. The forward end of each revolving bar passes through a pulley wheel, about seven inches in diameter, a band passing from one to the other, and crossed so as to make both bars revolve inwards.

In cultivating a few acres, the machine may be simply dragged along upon the ground. But as Mr. Squires raises from twenty to thirty acr of potatoes yearly, he attached the machine to the forward wheels of a light wagon, suspended by a chain to the axle-tree, so that the forward end of the drag barely touched the ground, and thus greatly facilitated the draft. The driver sits upon the axle-tree, with his back to the horse and his feet upon the platform, and turns the crank, sitting a little sideways so as to direct the horse at the same time.

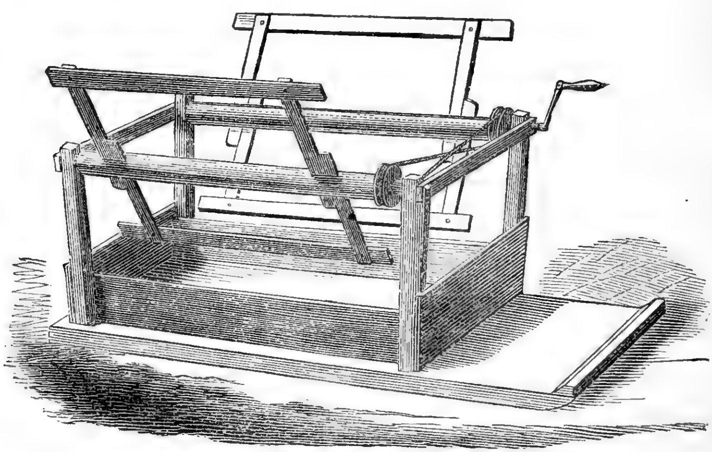
In answer to questions put to Mr. Squires, the following additional information was obtained:

The machine was made in less than half a day, and did not cost over four dollars. Those who used it were the only ones in that neighborhood, with one exception, who harvested any potatoes. Mr. Squires had sold a thousand bushels of potatoes at a dollar a bushel, and had half as many more left. The machine operates most successfully upon vines from four to twelve inches high. It knocks off nine-tenths of the beetles and larger grubs, but does not remove many of the very small ones. A man can easily go over fifteen acres a day, and he had once bugged ten acres in half a day. The potatoes being on ridges, the machine drops a little below them, and this explains how bugs can be knocked from vines only four inches high into a box of the same hight. In answer to the question whether it would not be a good plan to line the box with zinc, to prevent the bugs from crawling out, Mr. Squires replied that the bugs do not attempt much to crawl out of the box. The blow which knocks them in, partially stupifies them for a time, and the continual whipping in of the vines by the flappers tends to knock them back. If many of them are attempting to crawl out at any time, they can be jarred down by a sharp rap on the sides or ends of the box.

The bugs are disposed of by burying them in perpendicular holes, covering them with a foot of earth and stamping it down. At first Mr. Squires thought it necessary to kill the bugs, and drenched them with strong lime-water, but he found this to be unnecessary. The bugs thus buried, en masse, soon perish

We have not space for comments, but every reader can draw his own conclusions. The machine could, no doubt, be improved by experience and ingenuity. The one which we saw was a rough and cheap, but effective piece of work; but these are the very qualities which make it available to the common farmer, and which have appeared to us to justify this somewhat extended notice of it. If this machine proves as successful in the hands of others as it did in those of the inventor, it will supply an important need in potato culture upon a large scale.

The Paris green will still have to be used whilst the vines are small, or until they are four or five inches high, but at this time its application is very easy, and it requires comparatively little of the poisonous material; and we cannot too often reiterate that experience has shown that the Paris green may be, and ought to be very largely diluted, that is to say, with about twenty times its bulk of flour or lime, or other inert powder.



THIRD ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST OF ILLINOIS.

DECEMBER 20, 1872.

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PART FIRST.

PART SECOND.

INTRODUCTION.

[Third Report.]

To His Excellency, John L. Beveridge,

Governor of the State of Illinois:

Sir—I herewith submit my third annual report upon the insects, injurious and otherwise, of the State of Illinois.

It will be seen that in a part of this report I have stepped aside from the ordinary form of entomological reports of this kind, for the purpose of giving assistance to the young people of this State and others who are taking an interest in this subject, in its scientific as well as its practical relations. I have been induced to take this course by the following considerations:

In the original enactment by which the office of State Entomologist was created in this State, it was made the duty of the incumbent to make an annual report upon the insects of the State, especially those injurious to the agriculturist, and also to make a general collection of the insects of the State, to be deposited at the Industrial University. As the great majority of insects are not injurious to mankind, and as a general collection of insects is merely a pretty but useless show, unless something is known of their habits and classification, it may be inferred that, in requiring such a collection to be made, the founders of this office took an enlarged view of the subject, and had an eye to the advancement of the scientific as well as the more directly practical interests of the State.

By a recent enactment of the General Assembly of this State, it is required that the study of natural history shall be made a branch of the popular education. Of the great number of young people who will thus be induced to direct their attention to this subject, there must be a considerable number whose tastes will lead them to prosecute the study to a greater or less extent. This class of students will not be satisfied with the superficial knowledge which they may be able to obtain from the instructions of teachers, most of whom cannot be expected to have made a special study of the natural sciences. Especially must this be true of

so extensive and difficult a science as that of entomology. It seems desirable, therefore, that there shall be some work of easy access, which shall assist them in their studies, and at the same time serve as a stepping-stone from such teaching as they may be able to obtain at the public schools, to the more learned and elaborate treatises upon this science.

As many reports and treatises have already been published by the entomologists of this and other States, intended especially for the use of the practical farmer and horticulturist, in which the habits and the treatment of the most injurious insects have been pretty fully described, it seems the more admissible and proper, at this time, to give some assistance to that class of students who have the time and inclination to prosecute this subject in all its relations. In this way we may give encouragement to many young enquirers, which will stimulate them to acquire a more thorough knowledge of the subject, and one which they may hereafter turn to practical account, both for themselves and others.

It must be borne in mind, however, that the main object of this office is of a directly practical nature, and if reports of a more scientific character are occasionally published, the subject should be so treated as to show, as much as possible, the connection between scientific and practical entomology. With this end in view, I have, in the present report, made the food and the food-habits of the insects treated of the basis of classification, it being in this connection chiefly that insects are injurious to human interests. By this means the student who has acquired the art of referring insects to their natural connections by the examination of their external structure, will be able to determine whether any species which he may have in hand be injurious, or liable to become so, by knowing the habits of the family or tribe to which it belongs.

It will be seen that the present report consists of two parts: the first being devoted, as usual, to the consideration of injurious insects; and the second part being the first installment of the elementary treatise in general, referred to in the preceding remarks. In my next report I contemplate completing that part of the work which treats of the large and important order of Coleoptera, or beetles.

The value of an elementary work like this, intended chiefly to aid the inexperienced student, must depend very much upon its being suitably illustrated by figures. A bill making an appropriation for this purpose was introduced into the Senate, at the recent session of the General Assembly, and passed to a third reading without opposition, but so near the close of the session that it failed to reach the lower house. It is anticipated that this bill will be passed at an early stage of the adjourned session; but the delay is a matter of regret, since the figures may require a considerable time for their preparation, and they cannot be commenced till it is known with certainty that the appropriation will be made.

The cuts in the first part of this report were engraved from drawings made by Mr. C. V. Riley, State Entomologist of Missouri.

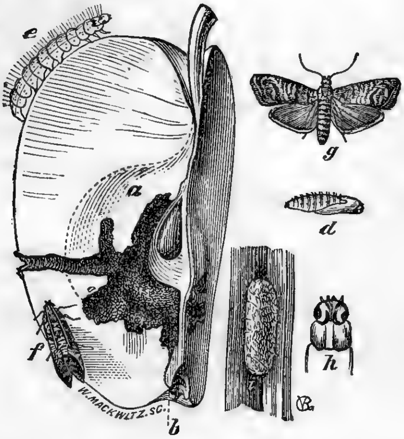
The elaborate figure of *Harpalus caliginosus*, illustrative of the external anatomy of the Coleoptera, was engraved from a copy, reduced by photography, from a gigantic drawing made by Mr. Franklin C. Hill, of Yellow Springs, Ohio, and kindly put at my disposal by the author.

Respectfully submitted,

WILLIAM LEBARON,
State Entomologist.

GENEVA, *December* 20, 1872.

INSECTS INJURIOUS TO THE APPLE.



Explanation.—*a*, section of an apple which has been occupied by a Codling-worm, showing the point of entrance of the worm at *b*, and the place of exit of the mature worm at the left hand side of the figure; *e*, the full grown worm; *h*, its head and first segment magnified; *i*, the cocoon; *d*, the pupa removed from the cocoon; *f*, the moth with wings closed; *g*, the same with wings expanded.

THE CODLING-MOTH, OR APPLE-WORM.

(*Carpocaspa pomonella*, Linn.)

Order of LEPIDOPTERA. Family of TORTRICIDÆ.

In a classification of fruit-damaging insects, in the order of the degree and extent to which they are injurious to human interests, the Codling-moth, which is the parent of the common apple-worm, must undoubtedly hold the first place. And it would occupy this position, not only because the apple is the most valuable of fruits, but on account of the great extent of territory over which it prevails, not being limited to this country, but being also an inhabitant of the British Islands and the continent of Europe, where its habits and history were long since noticed and described.

We propose, in this article, to give the results of our personal observations upon this insect for the past two or three years. We will first give a brief outline of its natural history, and then notice more particularly those parts thereof which are not generally known, or about which a difference of opinion has existed.

ITS HIBERNATION.

The Codling-moths pass the winter in the larva state enclosed in cocoons, which are concealed, for the most part, under the more permanent scales ,or in the deep fissures of the bark or wood of the tree, in the fruit of which they were reared. Those which have been taken with the fruit into the fruit-room or cellar, are often found in great numbers under the hoops on the barrels, or in cracks of the apple bins. It is a curious circumstance in the history of this insect, that the late brood of worms, after they have enclosed themselves in cocoons, retain, as above stated, the larval form all winter, and do not change to pupæ till within two or three weeks of the time when they emerge as moths in the spring. All testimony agrees upon this point. The summer brood, however, pursue the usual course, and change to pupæ in the course of two or three days after they have spun their cocoons.

TIME OF APPEARANCE IN THE SPRING.

The moths begin to make their appearance about the time of the opening of the apple blossoms, or soon thereafter; the time varying several weeks, according to the latitude and the character of the season. Last year (1871) the moths were first noticed north of the center of this State on May 20. The present season, in the latitude of Chicago, I first saw a moth on the 12th of May, the apple trees being in pretty full blossom; but the pupæ which I had kept through the winter did not begin to open till the last week in May; and Dr. James Weed, of Muscatine, Iowa, states that on one occasion, upon examining the pupæ which had remained under the trap-bands through the winter, nearly all were found unchanged on the 25th of May. The time of their appearance will, of course, be earlier further south, to the same degree that vegetation is earlier; the difference in this respect being expressed with sufficient accuracy by the rule of adding or subtracting, as the case may be, about one week for each one hundred miles of latitude.

TIME AND PLACE OF EGG-DEPOSIT.

The moths deposit their eggs, one at a time, usually in the calyx end of the apples, as soon as they are out of the blossom. The moths themselves, on account of their smallness, the general obscurity of their coloring, and their nocturnal habits, are very rarely seen, but we know that they deposit their eggs at the calyx end because we can trace the burrow of the young worm from that part; and the other points above stated are known by a similar *ex post facto* method of reasoning. As insects are known often to exhibit a wonderful apparent prescience in their operations, we may fairly conclude that the final object of the habit

of this species, in laying its eggs in the calyx end of the apple, is to avoid interferance with the connection of the apple with the tree by means of the stem, and thereby ensure its attachment, till the worm within shall have nearly or quite matured its growth. We shall have occasion to refer to this point more particularly in the sequel.

SUBSEQUENT HISTORY.

The eggs hatch in the course of a week after they are deposited. The young worm is so small that it is not easily seen without the aid of a lens. It is white, with a black head and collar, and a black spot on the top of the last segment. There are eight black dots on each segment, so arranged as to make four rows, extending the length of the body. As the larva increases in size the black parts become brown, the dots become pale, grayish and often indistinct, and the body assumes more or less of a pinkish tint.

The young worm, as soon as hatched, eats its way directly, but by a slightly tortuous course, to the core of the apple, throwing out its castings through the hole by which it entered, and which it must somewhat enlarge for this purpose. A portion of the castings adhere to the shrunken calyx upon the outside of the apple, in the form of a dark rust-colored mass, which can be easily seen from the ground beneath, and which thus enables us to distinguish the wormy apples at a considerable distance.

Arrived at the core, the worm subsists for a time mainly upon the seeds, which appear to be peculiarly agreeable to its taste; and it is very common to find a worm at this stage, completely enclosed in the hull of an excavated seed. When half grown or more, they usually make their way to the side of the apple and cut a comparatively large hole, through which to discard their castings; and through this hole the matured worm ultimately makes its exit. It is not very uncommon, however, for the worm to enlarge the passage by which it entered, and to pass out by it, in which case no side hole is made.

A part of the wormy apples fall to the ground, but not usually until the worms are nearly or quite matured, and a part remain adherent to the tree for a time after the worms have left them. Whether the apples fall or not, depends partly upon the variety, (some kinds being much more strongly adherent than others,) and partly upon the occurrence or not of strong winds. In exceptional cases apples which have harbored worms adhere to the tree all winter.

The worms which leave the fallen apples, as a general rule, make their way to the tree, crawl up its trunk and spin their cocoons under the scales of bark on the trunk and larger branches. Those which leave the apples on the tree, either let themselves down to the ground by a

thread, and then it may be presumed crawl up the trunk, or crawl down the branches and spin up under the first convenient shelter that offers. Whilst observing insects in the orchard, by lamp light, I have seen the Coddling-worm, in a few instances, descending in each of the ways here specified, and the reason we have not seen more of them so doing, probably, is that they are nocturnal in their movements.

The summer brood of these insects remains in the pupa state about two weeks. In the latitude of Chicago, the great majority of moths of this brood emerge in the last two weeks of July and the first week of August. After pairing they proceed to deposit their eggs upon the now partly grown apples. It is these eggs which produce the second or autumnal brood of worms, which damage our ripening fruit, and many of which are gathered with it at the harvest.

LENGTH OF LIFE IN ITS SEVERAL STAGES.

This may be expressed, with respect to the summer brood, with approximate accuracy, by weeks, as follows: Egg state—one week; larva state—four weeks; pupa state—two weeks; imago or moth state—one week; being eight weeks, or two months in all. Each of the three first stages is known to be shortened from one to three days under favorable conditions; but as there is reason to believe that the moth may live somewhat longer than the above estimate, the aggregate duration of life will not vary much from that stated. The life of the second brood, which survives the winter, extends through the remaining ten months of the year.

Having thus given a brief outline of the common or average history of this insect, we proceed to notice those points which are exceptional or less generally known.

NUMBER OF WORMS IN THE SAME APPLE.

We have stated above that the female moth deposits her eggs, one at a time, in the calyx end of the apple. This is the general rule. The exceptions, however, are not so rare as has been supposed. I see from my notes that in the examination of a large number of wormy apples on the 19th and 20th of August, ten instances of two worms in the same apple occurred; and on the 21st of the same month, upon examining two or three dozen wormy pears, four additional cases of this kind were observed. In almost all these instances it is found that the first, and consequently the larger worm, entered at the calyx end, and the second one at some other part, usually at the side, but sometimes at or near the stem. The habits of the Codling-moth in depositing its eggs may be explained in the following manner: At the time of the appearance of the first brood of moths, the apples are very small and incapable of supporting more than one worm, and the Codling-moth has the wise in-

stinct to lay but one egg on the same apple, and what is still more remarkable, she must have the instinct to avoid those apples which have been already appropriated to this purpose; since, otherwise, we should oftener find more than one worm in the same apple. At the time when the second brood of moths appears, circumstances have become changed, and the instincts of the insects are somewhat modified accordingly. The apples have now become large enough to support more than one worm, and the moths, though adhering, in the main, to their original instinct, sometimes depart from it to a limited extent. But even here the same moth never lays but one egg on the same apple. The fact that where there are two worms in the same apple, they are almost invariably of different sizes, shows that they are undoubtedly the offspring of different parents.

DURATION OF THE IMAGO OR WINGED STATE.

It is well known that many insects, after they have arrived at their mature and winged state, have the mouth-organs wanting or rudimental, and consequently that they take no food at this stage of their existence. The life of these insects, after their maturity, probably does not much exceed a week, and this brief period is wholly occupied in pairing and depositing the eggs by which the species is to be perpetuated. The tongue of the Codling-moth is very short, and when raised artificially, scarcely exceeds the head in length, and appears to be rather obtuse at the end. The apparent imperfection of the organ, and the fact that the moth has never been seen eating in the state of nature, has led to the supposition that this insect belongs to the category of non-feeding imagos. This, however, is not the case. Upon putting lumps of moist sugar, and also slices of sweet apple in the boxes in which a number of these moths were enclosed, I have seen then feed upon both these substances, especially the latter; eight or ten moths sometimes alighting upon the same slice of apple. The tongue, when extended by the voluntary act of the insect, is seen to be slender and pointed, and nearly double the length that it appears when not in use. They feed greedily but awkwardly, their flexible tongues bending in every direction against the resisting surface, and giving rise to the probable supposition that, in the natural state, they feed, like most other moths, upon the honey of flowers, and most probably, in part at least, upon that contained in the blossoms of the apple tree. I have kept many of these moths in boxes without food, and have never known them to live beyond the seventh day.

I have dwelt upon this point more particularly, because it enables us to explain how it is that newly hatched worms are found in apples, to a limited extent, all through the summer, showing either that the moths must vary much in the time of their emergence in the spring, or else,

what now appears possible, and more probable, that the moths may live and continue to deposit their eggs for a period of several weeks. This view is confirmed by the unequal development of the eggs, as seen in the ovaries of the female moths. Upon dissecting these moths within a few days of the time of their emergence from the pupa state, for the purpose of counting the eggs which they contain, I have found it very difficult to determine the number, for the reason here given. Whilst in in many moths, such as many, if not all of the Bombycidæ, the eggs are developed and deposited at one and the same time, in the Codling-moth the eggs are to be seen in all stages of development, analogously to those found in the domestic fowl. By carefully unfolding the ovaries in water, they can be traced to their origin, with the contained ova of gradually diminishing diameters. This condition of the ova implies that they are developed and therefore probably deposited successively and for a considerable time. I have usually succeeded in counting from forty to sixty tolerably developed eggs, making an average of about fifty. But if all the undeveloped eggs come to maturity, this number must be considerably increased.

MORE THAN ONE BROOD.

The testimony is somewhat conflicting upon this point, and must probably be explained by the circumstance that the habits of this insect have been observed in different latitudes and in widely remote localities. Dr. Harris expresses the opinion that it is usually single brooded in New England, but it is universally double brooded, at the West; at least in all parts of the State of Illinois, and farther south.

The same discrepancy exists in the reports from different parts of Europe. M. Zeller, the distinguished microlepidopterist of Stettin, in the northern part of Prussia, as quoted by Mr. Riley, states that this moth is single brooded in that latitude, whilst M. Schmidberger, in Kollar's Treatise, writing in the latitude of Vienna, about five degrees or nearly three hundred and fifty miles farther south, describes the moths as depositing eggs for a second brood.

PRACTICAL TREATMENT.

This may be reduced to the four following heads:

1st. Destroying the insects in their winter quarters.

2d. Picking the wormy apples from the trees.

3d. Gathering the wormy apples from the ground, or letting swine and sheep have the range of the orchard.

4th. Entrapping the worms in bands and other contrivances.

To which may be added the help to be derived from their natural enemies.

1st. *Destroying the insects in their winter quarters.*—When we consider that each female moth is capable of laying fifty eggs, or more, and that every worm of the first brood ruins an apple, we can see the importance of destroying these insects before they leave their winter quarters. We have already stated that, in the state of nature, these worms pass the winter in cocoons, concealed under the bark, or in the crevices of apple trees. The summer brood of worms which remain but two weeks in the pupa state, sometimes content themselves with a very slight protection, but it is the nature of the insect to seek deep concealment; and the instinct of the second brood, which is to survive the winter, leads them to search for the deepest protection they can find. We therefore rarely find them under shallow and loose scales of bark, but very often in deep cracks and crevices, partially embedding themselves in the substance of the wood or bark. Any superficial scraping of the trees, or white-washing, or other outward applications, would not therefore be likely to reach many of them. And inasmuch as they may be hidden upon any part of the trunk or large branches, any attempt to discover them with the intention of digging them out, would evidently be impracticable. But at the point where we become powerless, the woodpeckers come to our aid. In their search for just such hidden worms as these, these busy foragers unite business with pleasure, and all through the wintry day the sharp rattle of their beaks may often be heard in the orchard, as with ear intent, and sharpened beak, and appetites not less sharp, they pursue their hidden prey with unerring and fatal precision.

A more efficacious way of destroying these worms, so far as our own instrumentality is concerned, is to search for them about the barrels and bins in which fall and winter apples have been kept. I have heard of instances where the side-boards of the bins have been taken away from time to time, as the apples were removed, and thrown one upon another, in which these boards became so fastened together by the webs of the worms between them, that a number of boards could be raised by taking hold of the upper one only. There can be no doubt that the destruction of the Codling-worm at this stage of its existence, would be very effective, and that it has been by far too much neglected.

2d. *Picking the wormy apples from the trees.*—We have stated above that the young worms, soon after they have entered the apple, begin to throw out their castings through the hole which they made in entering. As this hole must be originally almost microscopically minute, it is evident that they must enlarge the opening for this purpose. We further stated that a portion of the castings adhere to the rough and shrivelled calyx, forming a rust-colored mass, which is easily seen from the ground below. Some horticulturists, amongst whom we may mention Mr. Oliver

Chapin, of East Bloomfield, New York, and Mr. L. Barnes, of Bloomingdale, Illinois, have availed themselves of this circumstance for the purpose of removing the wormy apples from the trees, before the worms have escaped. Mr. Chapin's plan is to beat off the wormy apples, but Mr. Barnes adopts the method of picking them off by means of a wire hook attached to the end of a pole. These two methods can be very usefully combined by first jarring or beating off those apples which readily fall, and then going over the trees a second time with the pole and hook. The apples thus removed should, of course, be fed to swine or otherwise treated so as to destroy the worms within. Too much value cannot be attached to these simple expedients, which, in the case of a few choice trees or even a small orchard, might almost be made to supercede the necessity of any other treatment.

3d. *Gathering the wormy wind-fall apples from the ground, or letting swine or sheep have the range of the orchard.*—This plan has been generally recommended as of very great importance. Its efficacy will depend, of course, upon the proportion of worms which fall to the ground in the apples, as compared with those which leave the apples whilst hanging upon the tree. Those which crawl down the branches spin up before reaching the ground, and those which let themselves down by a thread, would, for the most part, be detected only by birds or by domestic fowls, and as there is reason to believe that they usually perform this act in the night, even these must fail to capture them.

With regard to those wind-falls which contain worms, it is necessary to gather them frequently, that is, every day or every second day at farthest. The apples do not usually fall till the worms are nearly matured, and they leave them in the course of a few days. If you examine indiscriminately a large number of wind-fall apples lying under the trees, you will be surprised to find how few worms they contain, they evidently having left the fruit before it fell, or soon after.

But the most important question in this connection is, what proportion of the worms leave the apples before they fall from the tree? I have endeavored to arrive at an approximate estimate upon this subject, by putting two or more bands upon the same tree, upon the presumption that the worms descending from above will spin up in the upper band, and those crawling up from the ground, in the lower. The following tables, numbered for the purpose of reference, give the results of these experiments. The wind-fall apples in every case were left as they fell upon the ground.

On the tenth of July, (1871,) I put bands as follows upon four trees, the ground underneath being bare, or free from grass or rubbish of any kind. One band was put about a foot from the ground, another about two feet higher on the trunk, and others on two or three of the larger

branches, eight or ten feet from the ground. They were examined July 28th, eighteen days after they were put on:

No. 1.

Whole number of worms in all stages		220
Number of empty pupa cases	38	
Number pupæ	127	
Number of enclosed but unchanged larvæ	55	
	—	220
Number of all stages in lowest bands	94	
Number of all stages in upper trunk bands	83	
Number of all stages in bands on limbs	43	
	—	220

No. 2.

(Same trees examined August 11th, two weeks later.)

Number of pupa cases	16	
Number of pupæ	34	
Number of larvæ	15	
	—	65
Whole number in lowest bands	21	
Whole number in middle bands	13	
Whole number in bands on limbs	31	
	—	65

No. 3.

(Same trees—August 25th, two weeks from last.)

Number of pupa cases	1	
Number of pupæ	4	
Number of larvæ unchanged	41	
	—	46
Number in lowest bands	24	
Number in middle bands	15	
Number in bands on limbs	7	
	—	46

No. 4.

(Same trees—September 9th, fifteen days later—Found larvæ only.)

Number in lowest bands	33	
Number in middle bands	39	
Number in bands on limbs	9	
	—	81

No. 5.

(Same trees—September 23d, two weeks later—Larvæ only.)

Number in lowest bands	28	
Number in middle bands	22	
Number in bands on limbs	4	
	—	54

No. 6.

On the fourth of July, (1872,) I selected a smooth, thrifty apple tree, six inches in diameter, growing upon grass land, and well filled with apples, bearing many marks of being wormy, but remarkably tenacious,

and consequently but few lying upon the ground. Put two bands upon the trunk, one a foot and a half above the other.

Examined July 23d, a moderate number of apples having in the meantime fallen upon the ground:

Whole number in the lower band	150	
Whole number in the upper band	110	
	—	260

The bands in this experiment were made of carpet six inches wide and long enough to go twice round the tree, making a very abundant covert for the worms. As might have been anticipated, in this case the greater part of the worms in the upper band were found in its upper half, indicating that the worms had reached it by descending from above; and, on the other hand, the greater part of the worms in the lower band were in its lower half, showing that they had come up from the ground. We say the greater part, but not all: implying that some worms in each case had passed over one band and gone on to the next.

The above tables furnish data for many interesting and practical deductions.

First, as respects the question now under consideration, namely, What proportion of the worms leaves the apples before they fall from the tree; if we add together all the worms found in the highest and the lowest bands, respectively, and divide those found in the middle or upper trunk bands equally between the other two, we shall have four hundred and thirty six in the lower bands, and two hundred and ninety in the upper, implying at first view that much the larger number came up from the ground. But there are several circumstances in these experiments which must be taken into account, and which will somewhat modify this conclusion. First, many of the limbs had no bands upon them, and the worms from these may be presumed to have found covert chiefly in the upper bands on the trunk. Second, two of the trees experimented upon were large rough trees, and a part of the worms undoubtedly spun up under the scales of bark on the limbs above the bands. And, thirdly, we do not know what proportion of the worms may have let themselves down to the ground by threads, and then found shelter under the lowest bands. Taking these circumstances into account, we shall perhaps arrive at an approximation sufficiently accurate for practical purposes if we divide the whole number of worms equally between the upper and lower bands, from which we infer that about half of the worms crawl down the tree, and the other half reach the ground either in the apples or by threads. We must infer from this, so far as one series of experiments enables us to judge, that the gathering of windfall apples, either by ourselves or by the aid of domestic animals, enables us to destroy less than half of the Codling-worms.

The animals used for this purpose are hogs and sheep. The latter are more cleanly, and equally effective, but they are liable to damage young trees by gnawing the bark. Mr. A. R. Whitney, of Franklin Grove, has pastured sheep in his large orchards for years, without any injury of this kind. Sheep seem to differ in their tastes in this respect; but the result will probably be found to depend generally upon the size and age of the trees, and upon the circumstance whether there be a sufficient supply of other food.

4. *Entrapping the worms under bands and other contrivances.*—The well known habit of the Codling-worms to seek shelter, when about to transform, under the scales of the bark of the trees upon which they have been reared, long ago suggested the idea of entrapping them under some artificial covert in which they could be easily destroyed. More than fifty years ago, Mr. Joseph Burrelle, of Quincy, Mass., practiced the method of winding pieces of old cloth around the trunks of the trees, or hanging them in the crotches; and subsequently Dr. Trimble, of New Jersey, suggested the substitution of hay bands in large orchards. These different methods have been largely put in practice, and are now regarded as the most effective remedy against the damages of the Codling-moth. The tables given above furnish sufficient examples of the effectiveness of this process, showing that seven hundred and twenty-six worms were captured on five trees, three of which were small trees not more than six inches in diameter.

The materials commonly used are bands of hay, or of cloth, or traps made by placing two or three pieces of thin board or shingle one upon another, and fastening them to the tree by a screw through the middle. The hay bands are the least convenient, and are resorted to only when a sufficiency of material for the cloth bands is not at hand. Where material is abundant, the cloth bands should be from four to six inches wide, and long enough to go twice round the tree, one layer upon the other. In my first experiments I used cotton bands, and found the worms rarely between the folds, but usually under the bands, more or less embedded in the bark. The next year I used strips of old carpet, which seemed to be more satisfactory to the insects, as many of them sought protection between the layers. These bands can be kept in their place either by a nail driven through the loose end into the tree, or by a piece of twine tied around the middle of the band. They must be taken off and examined at certain intervals, and replaced after the worms within and beneath them have been destroyed. An expeditious way of killing the worms has been suggested, by running the bands through a common clothes wringer.

The shingle trap is a recent invention of Messrs. Thomas and D. B. Wier, of Marshall county, in this State. It is an extremely simple contrivance, made usually of three pieces of old shingle, new shingles being

objectionable on account of their terpentiny odor. The pieces may be about a foot long and from four to six inches wide. The three pieces for one trap should be of different widths, the narrower ones being next to the tree. It is recommended to put a few piece of straw between the shingles, letting them project beyond the edge, partly for the purpose of keeping the pieces slightly apart, and partly to serve as conductors to the worms. There can be no doubt that the covert furnished by these pieces of wood, lying in juxtaposition, is a very congenial one to these insects. It is the same in its nature as that afforded by the boards of apple bins, which are often found glued together by the accumulated cocoons of these insects. Another similar instance is that furnished by the partial splitting down of the crotch of forked limbs, where hundreds of worms are sometimes found imbedded in the cleft thus made. Mr. D. B. Wier performed a number of experiments for the purpose of testing the efficacy of these traps in comparison with the hay and cloth bands. When put to similar tests, the result stood as follows: cloth bands, 27; straw ropes, 36; Wier's trap, 74. In another trial, from 43 to 188 worms were found in each trap, at the end of every ten days.

The obvious imperfection of these traps consists in the very limited extent of their contact with the tree, so that unless many traps are placed upon the same tree, the worms are liable to pass by them; though it is possible that if no other covert be found, a part of the worms may return to them. The claim that has been set up that the traps attract the worms from a distance, so that one, or at most two, traps to a tree are all that are necessary, is improbable in itself, and does not bear the test of experience. The following experiments with these traps were performed by me during the past summer.

Early in the season I put upon the trunk of each of four apple trees, two of Mr. Wier's traps, on opposite sides, one higher than the other, so as to admit a carpet band six inches wide between them. Of course no worm could reach the bands without passing by one or the other of the traps, or rather its horizontal range. These appliances were examined on the 26th of July, with the following results:

Number of worms in the upper traps	36
Number of worms in the lower traps	44
Number of worms in the cloth bands	188

The traps were made of but two pieces each. The pieces for two of them were sent to me by Mr. Thomas Wier for experiment. The other two were made each of one shingle six inches wide, sawed across in the middle and one half laid upon the other. The traps would have been more effective undoubtedly if each had been made of three or four pieces. But the experiment, as it is, shows that the shingle traps possess no special attractions. Mr. Wier claims, as one of the chief advantages of his traps, that the worms can either be taken from them, or crushed be-

tween them by rolling one piece upon another, much more exepditiously than they can be destroyed in the bands. The bands, on the other hand, possess the obvious advantage of completely surrounding the tree and thus intercepting the passage of the worms on every side.

We advise every orchardist to try both of these methods and retain that which proves, in his hands, to be most effective and convenient. A sample of the most approved pattern of the shingle trap can be obtained by application to Mr. D. B. Wier, of Lacon, or Mr. Thomas Wier, of Henry, Marshall county, Illinois.

In large orchards, where a sufficient supply of waste cloth is not at hand, the bands can be made of paper, folded two or three times, which will answer the purpose for one season. Coarse straw paper can be procured by the bale at such a price as to render the expense very trifling. The paper should be selected of such a size, that when cut into strips, they will reach around the trees. Such bands would, of course, be spoiled by scalding, but the worms might be killed some other way, or the bands could be renewed at a merely nominal expense.

It is evident that the bands must be put upon the trees as soon as the worms begin to leave the apples, and that they must be kept on all through the season, because the worms of the second brood continue to leave the apples as long as they hang upon the tree. But it is well established, as a general rule, that the worms of the second brood do not emerge as moths until the following spring, so that it is not necessary to examine the bands after the first brood have ceased to run, with the exception of one final examination late in the fall, or any time in the winter or early spring. Mr. Riley states that in the latitude of St. Louis the great majority of the worms of the first brood leave the fruit from the middle of May to the middle of June. In the lattitude of Chicago the time will have to be put a full month later. Indeed a very few worms in this latitude leave the apples in the month of June, and more than nine-tenths of the worms of the first brood leave the apple in the month of July. A good practical rule, which will apply to all latitudes and seasons, is to apply the bands at the end of one month from the time of the blossoming of the apple trees. They can be applied, of course, at any time previous to this when leisure permits.

HOW OFTEN AND HOW LATE MUST THE BANDS BE EXAMINED?

The intervals between the examinations must be somewhat less than the duration of the pupa state, for the obvious reason that the insects will begin to escape in the form of winged moths as often as this period elapses. The usual duration of the pupa state, in mid-summer, is about twelve or fourteen days, though it varies from ten to twenty. It will be seen, by referring back to table No. 2, that sixteen empty pupa cases

were found, though only two weeks had elapsed since the preceding examination, showing that in this time sixteen of the worms had entered the band, gone through with their transformations and emerged in the winged form, and therefore that in order to capture every worm that enters the bands, the examinations must be made oftener than every two weeks, say every ten or twelve days.

We have already stated that, as a general rule, the second brood of worms do not change to moths till the following spring, and therefore that it is unnecessary to examine the bands after the first brood have ceased to emerge, until we examine them once for all late in the season. What, then, is the dividing time between the two broods? This, like most other questions in natural history, can not be answered by drawing a straight line. The two broods overlap each other to a very limited extent, but not sufficiently to invalidate the adoption of general practical rules. If we refer back to tables Nos. 4 and 5, we shall see that at these examinations only unchanged larvæ were found, from which we infer that all the worms which entered the bands after the 25th of August belonged to the second brood. And in the preceding examination, embracing the period between the 11th and the 25th of August, only five out of forty-six worms had changed to pupæ. Judging from these tables we conclude that in this latitude the dividing time between the two broods is about the middle of August, and therefore that it is unnecessary to examine the bands after this date, until the final examination. If we put the time of the first examination on the tenth of July, and the last but one on the fifteenth of August, it will require three intermediate examinations at intervals of twelve days, making four summer and one fall or winter examination, or five in all.

By the collation of these dates we may adopt a general rule which will answer for all latitudes and seasons. Supposing the bands to have been applied at any convenient time within a month after the blossoming of the apple trees, then, allowing one week after the falling of the apple blossoms for the laying and hatching of the earliest eggs, thirty days for the growth of the larva and twelve days for the duration of the pupa state, it follows that the moths will not begin to escape from the bands till the expiration of seven weeks after the falling of the blossoms, and therefore that the first examination of the bands need not be made till a day or too previous to the expiration of this time. After this they must be examined three times at intervals of twelve days, and once more at the end of the season.

We may here add that these methods of entrapping the Codling-worms are much more efficacious upon young and smooth trees than upon old and rough ones, for the reason that upon the latter many of those worms, which leave the apples on the tree, spin up under the scales on the

branches, and therefore do not reach the traps. One of the trees experimented with was of this kind, being upwards of forty years old. In the summer of 1872 this tree was tolerably well filled with apples, the greater part of which fell to the ground in consequence of the injuries of the Codling-worms, and were allowed to remain there for the sake of experiment. Upon the trunk of this tree were put, early in the season, two of Wier's traps and a carpet band. These appliances were examined for the first time on the 26th of July, and then only thirty larvæ and pupæ were found in all of them; whilst from two other trees, not half as large, I obtained 129 and 260 worms, respectively. The only explanation I could give of this remarkable difference was that a large proportion of the worms had left the apples before they fell, and found shelter beneath the scales of bark on the limbs of this rough old tree. To determine this point I spent a couple of hours in picking off the scales on the large branches, and in this time discovered thirty worms or pupæ, the same number that had entered the traps, and yet I examined only a very small part of the tree's surface.

AID TO BE EXPECTED FROM NATURAL ENEMIES.

Those injurious insects which inhabit the substance of our fruits, such as the plum-curculio, the plum-gouger, and the codling-worm, escape in this way, to a great degree, the attacks of natural enemies, whether birds, or predaceous or parasitic insects—enemies to which the soft, naked, pinkish-white bodies of the codling-worm would otherwise offer a very tempting bait. The only time in their lives when they are exposed to view is the brief period after leaving the apple, and whilst seeking for a covert in which to spin their cocoons, and there is good reason for believing that they usually take advantage of the darkness of night for this purpose. In this way they must escape, to a great exient, the many kinds of small insectivorous birds, all of which are diurnal. Their only efficient enemies amongst the birds are the woodpeckers, whose instinct enables them to discover and devour them in their winter retreats. The boards of apple bins in open out-houses often bear unmistakable marks of the penetrating beaks of these busy insect-hunters, and I have seen the shingles of which Mr. Wier's traps were made, and which had been left on the trees through the winter, ruined for future use by being riddled with holes made by woodpeckers in digging out the worms concealed between the layers. The same instinct enables them to discover the worms in their natural retreats beneath the bark, and many of the insects are known to be destroyed in this way; and it is an encouraging circumstance that the worms which escape our traps by pupating upon the branches, are exposed to the pertinacious search of the woodpeckers all through the autumnal, winter

and vernal months. But that a goodly proportion of the moths escape all their enemies, our half-ruined apple crops abundantly testify. But though insects which inhabit fruits are in this way protected from many enemies, it is not to be understood that they wholly escape. Two species of Ichneumon fly are known to attack the larvæ of the plum-curculio, and Mr. Riley informs me that he has also bred two species of the same parasitic family from the larvæ of the codling-moth. I have also bred one species; but it is remarkable that from the hundreds of codling moths which I have reared from their larvæ, I have bred but a single individual of the parasitic Ichneumon, going to show how rarely they find an opportunity to sting these protected larvæ, and therefore how little we can expect from them in the way of practically reducing the numbers of fruit-inhabiting larvæ. *

There is another enemy of the codling-worm, of which, we believe, no public notice has been taken. Our attention was first called to it by a communication from Dr. James Weed, of Muscatine, Iowa.

On the 25th of July, 1871, I received from Dr. Weed a couple of white, elongate, somewhat depressed larvæ, between three and four-tenths of an inch in length, with a brown head and straight mandibles, with two brown spots on each of the three first segments, those on the first being sub-quadrate, and the others round and successively decreasing in size, and with a brown horny plate on the end of the last segment, from which project backwards a pair of short and slightly incurved spines. Dr. Weed stated that these were samples of a kind of predaceous worm which were found in considerable numbers devouring the larvæ and pupæ of the codling-moth, so that in some cases the pupæ under the bands were almost wholly destroyed by them, and that he had seen them, in several instances, with their heads immersed in the body of a pupa. Having had my attention drawn to this insect, I subsequently saw them, from time to time, under the bands upon the trees in my garden, and in one instance saw one of them in the act of eating a codling pupa. These little worms are the larvæ of a small, black, oblong and somewhat flattened beetle, belonging to the genus Trogosita. They exactly resemble the figures of the larva of the European *Trogosita mauritanica*, in Westwood's Introduction, Vol. I., p. 142, fig. 21; and also in Curtis' Farm Insects, p. 330, fig. 27. We have two common American species of this genus, the *T. castanea* and the *T. corticalis*, of Melsheimer, and I have seen the latter under the same bands with the larvæ.

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* In a letter received from Mr. Riley, since writing the above, he states that of one of the species of Ichneumon flies reared by him from codling-worms he has obtained but three specimens in all; but of the other species a much larger number. From one lot of 162 worms he bred 21 flies. He very plausibly conjectures that in these latter instances the worms were stung after they had left the apple, and probably after they had changed to pupæ.

The opinions heretofore entertained respecting the habits of the Trogositæ and their larvæ have been chiefly founded upon the history of the foreign species above mentioned, the *Trogosita mauritanica*, of Linnæus, subsequently named *T. caraboides* by Fabricius. These insects are often found in great numbers in stored grain in the south of Europe, where the larva has received the popular name of the *Cadelle ;* and one of the older French authors, M. Olivier, speaks of its doing more damage to housed grain in the southern provinces of France than any other of the destructive grain insects. The carnivorous habits of the perfect insect, however, had been noticed from time to time, and Mr. Curtis, after speaking of the injury done to grain by the larvæ, adds: "The beetle is carnivorous, and makes some amends for the mischief it had done in its larva state by destroying the *Tinea granella*."

The observations of a recent French author, M. Ed. Perris, upon the larva of another species of this family, lead to the conclusion that these insects are carnivorous also in the larva state, and M. Lacordaire, after referring to these observations, adds: "After this it is necessary to rectify what I have said above concerning the granivorous tastes of the larvæ of the *Trogosita mauritanica.* It is more than probable, as M. Perris suggests, that they do not touch the grain in which they live, but that they destroy, on the contrary, the larvæ of the grain beetles *(Calandræ)* and the caterpillars of the grain moths *(Tineæ* and *Alucitæ)* which are the actual authors of the mischief, and therefore that instead of being injurious, they render us a real service."

Our observations, above recorded, upon the carnivorous habits of the larvæ of some of our American species, go to confirm this view.

Before leaving the Trogositæ I may mention a curious incidental practice—I cannot call it a habit—of these insects. In the summer of 1871 one of the flouring mills in this town stood unoccupied, on account of the financial difficulties of the parties owning it. The miller having it in charge mentioned to me that the expensive bolting cloths in the establishment were being seriously damaged by some small black beetles which ate small holes through them, and would soon ruin them if they remained stationary, and that he was obliged to start up the machinery of the mill every day in order to save them. These proved, upon examination, to be the larger of the two species of Trogosita above named, and which I understand to be the *T. castanea.*

As an enemy of the codling-moth it appears, from the testimony of Dr. Weed, that the Trogositæ exercise a considerable efficiency in some localities, but we have not at present sufficient reason to suppose that they contribute much, upon the whole, to lessen the numbers of this destructive fruit insect.

To the above enemies of the codling worms must be added, upon the testimony of Mr. George W. Shaw, of Garden Grove, Iowa, the well known *Arma spinosa*, or Soldier-bug, which is known to be such an effective destroyer of the larvæ of the Colorado potato-beetle. Mr. Shaw writes to me that he has actually seen this predaceous insect (or possibly an allied species), in a number of instances, spear the codling worm with its sharp probocis, and draw it out from its burrow in the apple. This interesting statement rests at present, we believe, solely upon Mr. Shaw's testimony.

FUNGUS ON CODLING WORMS.

We occasionally find codling worms dead in their burrows, and covered with mould. Mr. Wier stated to me that he had met with so many instances of this kind that he had come to the conclusion that they are often destroyed by some kind of fungus. It seems to us a more probable explanation that these larvæ had perished from some other cause, and that the mould was a *post mortem* production.

SUMMARY OF REMEDIES.

We will briefly recapitulate the principal measures to be adopted with the view of destroying the larvæ of the Codling-moth:

1st. *Destroy the worms in their winter quarters.*—This we have shown to be an excellent rule so far as it is practicable. It is in this way that we derive our principal aid from birds, especially the Downy and the Hairy woodpeckers.

2d. *Pick the wormy apples from the trees by means of a wire hook attached to the end of a pole.*—The wormy apples are distinguished by the little mass of rust-colored castings which adhere to the withered calyx. This is also an excellent practice. Every apple thus gathered in the early part of the season contains a worm, and its destruction may prevent the propagation of a large number of worms of the second brood.

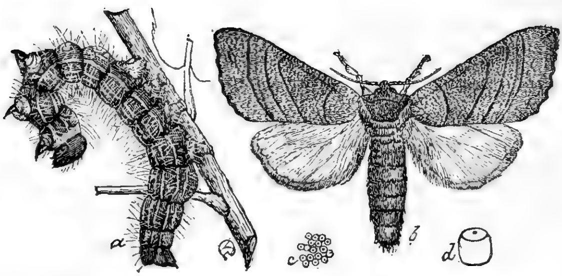
3d. *Gather the wind-fall apples from the ground, or let sheep or swine have the range of the orchard.*—Where it is convenient to let the domestic animals run in the orchard, it is well to do so. The apples will thus be economized, and by gathering them almost as fast as they fall, a considerable number of worms will be destroyed. But unless the gathering of wind-falls can be accomplished in this way, the method is scarcely worth the time and labor which its practice requires. And this is for two reasons: first, because a large proportion, probably more than half, of the worms leave the apples before they fall; and secondly, because the worms which remain have usually nearly attained their growth and are about ready to leave the apples at the time of their fall, and therefore, to be at all effective, the apples must be picked up as often as

every second day. The orchardist will hardly submit to this tedious labor when he knows that even from the apples thus frequently gathered more than half of the worms have escaped.

4th. Entrapping the worms in bands and other contrivances.—This we have shown to be a very effective method, especially upon comparatively young and smooth-limbed trees. Having sufficiently described these methods in the body of this article, we will here simply give the rules for applying and examining these traps.

Let the horticulturist make a memorandum of the time of the falling of the apple blossoms. Any time within a month after this date, the bands or other traps may be applied. Between six and seven weeks from the fall of the blossoms let the first examination be made; and after this make three other examinations with intervals of twelve days. Lastly, make one more and final examination, which may be done any time late in the fall, or in the winter, or in the early spring.

Before closing we will briefly advert to another practical suggestion upon this subject, made originally, we believe, by Dr. E. S. Hull, the well known horticulturist, of Alton, in this State. This is the method of throwing air-slacked lime upon the trees, when they are in blossom, or immediately thereafter. The idea is, that as the blossom end of the apple, at this incipient stage, points upward or outward, a sufficient quantity of the lime will lodge upon it to render it repugnant to the moth, and thus prevent her from depositing her eggs. We are not aware that this plan has been put in practice to a sufficient extent to test its efficacy. Two considerations occur to us which must prevent its being completely successful: first, that experience shows that the moths continue to deposit their eggs, to a greater or less extent, all through the earlier part of the season, and the lime would be liable to be washed off by rain; and secondly, many apples would be so protected by the foliage that the lime would fail to reach them. The idea, however, is an interesting one, and the efficacy of the method, like that of all others, would depend upon the thoroughness with which it was put in practice.



Explanation—*a*, the fully grown larva; *b*, the moth; *c*, a cluster of eggs; *d*, an egg magnified.

THE YELLOW-NECKED APPLE-TREE CATERPILLAR.

(*Datana ministra*, Drury.)

Order of LEPIDOPTERA. Family of NOTODONTIDÆ.

Synonyms:—*Phalæna ministra*, Drury. *Datana ministra*, Walker.
Pygæra ministra, Harris' Inj. Ins. p. 430. *Eumetopona ministra*, Fitch, Second N. Y. Rep., p. 235.

This moth varies from an inch and a half to two inches and a quarter across the expanded wings. The head and forepart of the thorax vary from buff-yellow to a dark red. The hinder part of the thorax and abdomen are dull yellowish of different shades. The forewings vary from a bright buff-yellow to a peculiar livid or smoky-brown, crossed by four or five narrow, dull reddish bands. The under wings are pale yellowish or whitish, but tinted more or less with the darker color of the upper wings, and with the posterior margin more deeply colored.

These various tints in the imago bear a certain relation to the varied coloration of the larva, and this seems to depend upon the nature of the different kinds of foliage upon which they feed. The larva, when fully grown, may be described in general terms as a black, moderately hairy caterpillar, with four conspicuous yellow or white stripes on each side of the body, and with the top of the neck, or first segment after the head, in most of the varieties, of a bright wax-yellow color. When fully grown they attain, under favorable circumstances, a length of two inches or a little more.

This brief description may answer the purpose of introducing the species of which we are now to treat. The moths, like most other nocturnal Lepidoptera, are seldom seen, but the larvæ, on account of their large size and peculiar habits, must often have attracted the notice of persons not usually interested in the subject of insects. They feed upon

the leaves of various trees, having been found on the apple, cherry, quince, oak, hickory, black walnut, black locust, birch, basswood, thorn, hazel and sumach. The eggs, from seventy to a hundred in number, are white and spherical, and are deposited in a dense patch, side by side, on the under side of the terminal leaves, so that the young worms have the newest and tenderest foliage to feed upon. They eat at first only the under side of the leaves, but as they increase in size they devour the whole leaf except the mid-rib. They do not spin any visible web, but are nevertheless strictly gregarious, feeding in dense clusters, and eating clean every leaf as they go. When all the leaves upon one twig or branch are consumed, they hastily migrate to another, sometimes making their appearance upon a remote part of the tree. When not feeding they often rest with their heads and tails elevated at right angles with the rest of their bodies, and they always suddenly throw themselves into this attitude when they are disturbed.

But what is calculated more than anything else to attract attention to these worms, is their remarkably gregarious habit at their moulting periods. They then come down upon the side of the trunk, and mass themselves together, very much after the fashion of a swarm of bees, sometimes making a quantity as large as could be held in both hands united. They maintain themselves in this position by means of shreds of web extending over and through them. Those which I have particularly noticed remain in this position two days and nights. Before the middle of the third day, those which have first accomplished their moulting, begin to crawl up the tree, and by the close of the third day nearly all have ascended. During this time they have cast off their outgrown skins, which are left dry and empty, attached to the web. They do not always come down upon the trunk to go through with this operation, but are sometimes seen attached, *en masse*, to the under side of the large horizontal branches.

These worms, like the larvæ of the fall web-worm, and the tent caterpillar of the forest, and some other social caterpillars, become less gregarious towards the close of their larval career, and after the last moult they often become quite solitary and erratic. They are one of the latest of our insects, never making their appearance before mid-summer, and being seen of different sizes from this time on, till the frost renders the foliage no longer fit for their nutriment.

As these insects all pass the winter in the pupa state, and are therefore in the same state of maturity when the summer opens, and as the female moth lays her eggs all at one operation, the question may naturally be asked how this succession of broods through the season is produced. It is evidently owing to the different periods of time that the insects remain in the pupa state.

About fifty of these larvæ, for example, which I reared last fall, and all of which entered the ground at about the same time, or in the course of four days, in the first week of August, began to emerge in the winged form on the tenth of the following June, and continued to come out till the end of the first week of July, and I have known the apple variety to emerge as late as the 18th of July. As these insects are of so large and conspicuous a size, and as the larvæ subsist upon the foliage of so great a variety of trees, they furnish one of the best examples in the whole class of insects, of phytophagic variation, or the variation of color, both of the larvæ and of the perfect insects, according to the diversities of their food-plants. As might be expected, some of these varieties differ but slightly from each other, whilst others, and especially those which feed upon the black walnut, differ so remarkably from the rest that they might almost be regarded as distinct species. Indeed, some recent writers upon our Lepidoptera have elevated most of these varieties to the rank of species, and have accordingly given to them distinct specific names.

In speaking of the two allied moths, the *Phycita nebulo* and the *Phycita juglandis*, in my second report, I had occasion to allude to the vexed question in natural history, whether there be any essential distinction between what are known as species and varieties; or whether these terms only express different degrees of permanency in allied organic forms, all of which are subject to change. Whatever opinion we may entertain upon this difficult subject, the practical question will often arise, in descriptive entomology, whether we shall regard and describe a particular kind of insect as a new species with a distinctive specific name, or let it stand as only a variety of another and previously known species. The well known test, applied to the higher animals, is that of uniting the sexes of the two allied forms, and observing whether the progeny have, or have not, the power of procreating their kind; the former being understood to indicate only varieties, whilst if the progeny are sterile, it is supposed to prove that the parents were of different species. But the application of this test requires so much time and attention that it can scarcely be expected to be practiced merely for the purpose of determining the specific identity of two allied insects.

A criterion often applicable to insects is that founded upon their food-habits, in accordance with the common rule that though the same species of insect will often feed upon closely allied plants, they will very rarely subsist upon plants of different natural families. But there are too many well known exceptions to this rule to admit of making it a test of specific identity. Indeed the larvæ of many of the moths belonging to the family of Arctiidæ, pay no respect to this distinction; and some of them, of which the *woolly bear* or larva of the *Spilosoma virginica* is a

familiar example, eat almost every plant which comes in their way, and have been known to subsist, for a time, upon the dead remains of other insects. The great diversity of foliage eaten by the different varieties of the *Datana ministra* cannot, therefore, be admitted as proof of difference of species.

A much closer test of specific identity is the tolerance of a change of food-plant. If two insects very similar, but yet with such differences as to render their specific identity doubtful, be found feeding upon different kinds of plants, and if, upon transferring each of them to the food-plant of the other, they continue to feed and thrive, it is generally regarded as affording the strongest presumptive evidence that they are only varieties of one and the same species; and inversely, if they each refuse to eat the food of the other, that they are specifically distinct. This is no doubt, in the great majority of cases, a correct and sufficient test. Can we go farther and hold it to be an unexceptionable rule? If we assume it to be such, it will follow that some of the different forms of the *Datana ministra* are distinct species; for we have repeatedly tried to change the black walnut variety to the apple tree, and the walnut and sumach varieties each to the food of the other, and in every instance they have persistently refused to eat. But this test does not appear to us to be of such a nature as to make it infallable. If two broods of some indiscriminate feeder, such as the larvæ of the *Spilosoma virginica* above referred to, should be so situated that they would be compelled to feed, each upon some one species of plant, and if this restriction should be continued through many generations, it would seem very probable that their tastes might become so confirmed that each would refuse to eat the food of the other, especially if the two plants were very unlike each other.

It will have been observed that the three trees to which we have above referred as the food-plants of the larvæ of Datana—the apple, the sumach, and the black walnut—belong to as many distinct families of plants, far removed from each other in their natural characters. But where their food-plants are botanically allied to each other, the larvæ can be transferred from one to the other without difficulty. I received, last summer, a number of half-grown larvæ which had been found upon the quince, and these were reared to maturity upon the leaves of the apple.

But let us proceed to describe some of the principal variations which occur in these insects, both in the larvæ and imago states, and see how far these variations seem to depend upon diversity of food-plants.

Without going into any extensive detail, we will take three of the most characteristic varieties, those found upon the apple, the sumach, and the black walnut, and point out the most striking differences. The larvæ described below are to be understood to have arrived at maturity.

Apple variety.	*Sumach variety.*	*Black Walnut variety.*
Body black, with four narrow, pale-yellow stripes upon the sides, narrower than the intervening spaces.	Body black; in some specimens, very dark-red, with bright lemon-yellow stripes as wide as the intervening spaces.	Body wholly black, without stripes.
Upper side of the neck, or first segment, deep, wax-yellow.	Top of neck black, sometimes with a narrow anterior margin of yellow.	Top of neck black.
Hairs upon the body whitish —about as long as the width of the body.	Hairs same.	Hairs pure white—twice as long as the width of the body.

The dissimilarity of the black walnut variety from the others, is very remarkable; so much so, that judging from the mature larvæ alone we should never suspect them to be the same, or even a closely allied species. But previously to the last moult, this variety is striped like the others, and it has precisely the same manners in feeding and moulting; and I have seen individuals, after the last moult, with short hairs as in the other varieties.

With respect to the coloration of the corresponding moths of these three varieties, a certain relation can be observed to that of their respective larvæ. The moths proceeding from the apple-feeding variety, are of a russet or reddish-brown color, varying considerably in shade in different individuals. These may be taken as the types of the *Datana ministra* proper. The moths from the sumach larvæ, with their broader and brighter yellow stripes, are of a pretty uniform buff-yellow color, with a conspicuous dusky spot a little below the upper extremity of the second transverse line, and a smaller dot opposite to it, between the first and second lines. This variety partially combines the characters of *D. perspicua* and *D. major* of Grote and Robinson, having the bright, buff-yellow color of the former, but without its confluent first and second cross lines, and the discal spots and other characters of the latter.

The moths from the unmixed black caterpillars found upon the black walnut, are much darker than the others, being of a smoky-brown color of different shades, but sometimes approximating to the russet brown of the apple and the oak varieties. The space between the first and second cross lines is usually darker in this variety, than the rest of the wing.

Besides their diversities of color the varieties of *Datana ministra* differ also, but only in a slight degree, in the number and direction of the cross lines, the proportional width of the wings, and the depth of the crenulations or little rounded notches in the terminal margin of the upper wings. But Mr. Walsh has shown by the comparison of many specimens, (Proceedings of the Ent. Soc. of Philadelphia for 1865, page 194) that these variations pass into each other by insensible gradations, and therefore that they cannot be relied upon as specific characters.

Dr. Fitch has given an account of this insect in his second New York Report, and points out the principal varieties, but without referring them to their corresponding larvæ.

We have spoken above of the comparatively late season of the year when the Datana-moths issue from the pupa state in which they have passed the winter. This circumstance might suggest an interesting inquiry into the causes which produce the great diversity in the periods of insect life. Not only do animal, as well as vegetable organisms occupy every part of nature's domain, but they are also widely distributed as respects the seasons of the year. As we have our spring, summer, and fall flowers, so we have our early and late insects, destined to keep in check the earlier and later vegetation. One way in which this is brought about is an unexplained difference in the time required for the development of different species of insects in the pupa state. Of the many moths which pass the winter in this condition, some emerge in the month of May, a much larger number in June, whilst a few, like the moth of the fall web-worm, and the *Datana ministra* of which we have here been treating, often lie dormant till well into July. The ultimate or economical reason for this diversity is sufficiently obvious, but the actual or physiological causes which produce it, are unknown, and perhaps unknowable. All we can say is, that it is their nature to do so. Here, for instance, are two chrysalids, lying side by side, belonging it may be to closely allied species, and scarcely distinguishable from each other. Yet one shall feel the first touch of sping and come forth, whilst the other shall lie dormant and motionless, heedless alike of winter's cold and summer's heat, till at length the dial points to the predestined hour in the cycle of its existance. Then, without any known or visible cause, the vital forces begin to circulate, and the creature exhibits tokens of reviving animation, within the darkened chamber of its sepulture. Gradually it rouses itself from its lethargy, and throws off its swaddling cerements, and puts on its beautiful garments, and comes forth to the light and liberty of a more exalted state of existance.

We do not mean to say that these changes take place without the operation of natural causes, but that these agencies are of so subtile a nature, and of so delicate an adjustment, that they will probably forever lie beyond the reach of human investigation.

PRACTICAL TREATMENT.

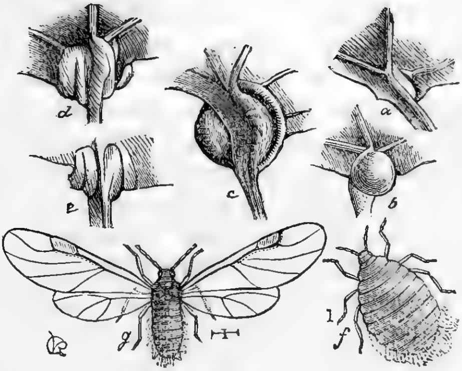
This insect has never been known to increase to any very serious extent, and it cannot be regarded, at most, as more than a third-rate injurious insect. We have occasionally seen small apple trees nearly defoliated by them; but our own experience has been mostly with the black walnut variety. We have an ornamental row of these trees which we

set out as seedlings twenty years ago. Scarcely a year has passed, since they attained a considerable size, that they have not been more or less disfigured by having some of their branches stripped of their foliage by these caterpillars. Some seasons they have been so numerous that we have thought it necessary to take measures for their destruction. They are eminently gregarious and therefore easily controlled. They feed side by side as closely together as they can stand, and when they are young a whole brood of them can be taken from the tree by removing a single compound leaf of the walnut. Later in the season, as we have above described, they come down, every time they moult, and mass themselves upon the trunk or large branches. As at this time they are bound together by web, they can be taken off *en masse* and consigned to to the flames.

They are, no doubt, kept largely in check by their natural enemies. We have reared from them two large species of Ichneumon flies, the *Ophion mundum* of Say, and another undetermined species.

I have often seen flocks of blackbirds alight upon the trees infested by these worms, but I was never near enough to determine whether they fed upon them. But I have seen that efficient destroyer of the hairy caterpillars, the American Cuckoo, in the act of devouring them. I observed that it always siezed the insect by one extremity, probably the head, and mashed it, by mumbling it between the tips of its mandibles for a time, before swallowing it. In the article upon Tussock-moth, in my first annual report, I described the manner in which I had seen the Cuckoo shave off the tufts of hair upon the larva of this moth, before swallowing it; but the larva of the Datana is but little hairy, especially previously to the last moult, and the only object that I can conceive the bird to have, in crushing the heads of these worms, is to destroy their vitality as nearly as possible. This is undoubtedly a wise precautionary measure, since the presence in the stomach of two or three dozen unharmed and squirming caterpillars could scarcely be compatible with that repose after a hearty meal, which is generally supposed to be conducive to digestion.

INSECTS INJURIOUS TO THE COTTON-WOOD.



Explanation.—*a*, incipient gall on the under side of the leaf; *b*, corresponding bulge on the upper side; *c*, fully formed gall, showing the lips slightly separated, so as to permit the escape of the mature insects; *d* and *e*, incipient double galls, one being located on each side of the mid-rib; *f*, the wingless female; *g*, the mature winged insect.

POPLAR-LEAF GALL-LOUSE.

(*Pemphigus populicaulis*, Fitch.)

Order of HOMOPTERA. Family of APHIDÆ.

The Cotton-wood *(Populus monilifera,* Aiton*)*, though one of the least valuable of our shade trees, is nevertheless worthy to retain its place among our shade-trees on account of its rapid growth, and the ease and certainty with which it can be propagated, thus often becoming available where other trees have failed. For these reasons there is a considerable demand for it, in proof of which we may state that we have recently seen a statement of twelve thousand of these trees having been shipped, upon one order, to a Swedish colony in Nebraska. The health and growth of the Cotton-wood, and some other species of the poplar family, are sometimes seriously impaired by different kinds of excrescences on the twigs and leaves, constituting what are technically known as galls, and formed by as many different species of the gall-making aphides. One of these is a large corrugated gall, formed on the ends of the twigs, often near the tops of the trees, turning black when mature, and adhering to the tree through the winter, and making unsightly ex-

crescences on the leafless trees. This gall is the work of the species first described by Mr. Walsh, under the name of *Byrsocrypta vagabundus.*

Another species, which is the subject of the present article, forms the swellings at the junction of the leaf-stalk with the leaf, often assuming a reddish tint, and growing to the size of a small marble. Unlike the former, this species is most abundant on the lowest branches, and probably always commences its operations upon this part of the tree. It is a widely spread insect, and its bullet-like galls must have been often observed, but very little has been recorded of its history. Mr. Walsh refers to it incidentally in some of his able and elaborate writings upon the gall-making insects; and Dr. Fitch described and named it many years previously, but evidently without having had an opportunity to study its habits. Though not itself an insect of much practical importance, its history has what may be denominated a *generic* value, in consideration of its belonging to the gall-making division of the extensive and important family of Aphides, and as helping to elucidate the origin and growth of these curious excrescences. Indeed, the manner in which the growth of galls takes place seems to be very imperfectly understood. Dr. Fitch, in his brief sketch of the present species, quotes from Mr. Rennie's "Insect Architecture," an account of the manner in which the gall of a closely allied European species is formed, reasonably judging that all galls of the same general character, or which are made by species of the same genus, are formed in the same manner. But Mr. Rennie's explanation has very much the aspect of a closet theory, and not a description founded upon actual observation. If insects could be supposed to be endowed, for a brief period, with superior intelligence, we can conceive that they would often be much amused at the theories which we, their more pretentious fellow-creatures, propound for the purpose of explaining their works and ways.

Mr. Rennie supposes that these galls are formed by an exudation of sap caused by the punctures of the insects, which subsequently becomes condensed and organized; but an inspection of the gall now under consideration, in its earlier stages, shows that it is first formed by a little fold of the leaf which encloses the insect, and that its subsequent enlargement is an excessive and abnormal growth of the surrounding tissues. The lips formed by the meeting of the folds of the leaf never become agglutinated, but remain in the form of a slit, like the mouth of a purse, which can be drawn open, and through which the matured insects ultimately escape. In the cases of certain other species of Aphides, such as the common species which infests currant leaves, the irritation of the insects simply causes bulgings of the leaf with intermediate hollows in which the insects repose. These corrugations might, therefore, be regarded as incomplete or abortive galls.

The incipient galls of the species now under consideration can be detected early in May, and by the middle of this month they are visible at a distance on account of their reddish tint. In the early part of the season each gall is occupied by a single, wingless, female aphis, which, by midsummer, becomes the mother of a numerous progeny, often amounting to one hundred and fifty in number. From the very small and tender condition in which this insect is first seen in the spring, not exceeding at this time the twentieth of an inch in length, it is probable that it passes the winter in the egg state, which is known to be the case with the Aphides generally. Upon examining the twigs of the Cottonwood with a lens, late in the fall, I have detected a small number of black eggs, about the fortieth of an inch in length, imbedded in the little folds at the base of the buds. As the eggs of some other species of Aphides are known to be deposited in similar situations, and to have the same black color, it is not improbable that these may be the eggs in question. The only circumstance which threw a doubt upon this point, was the very small number of these eggs that I could discover in comparison with the ordinary profusion of galls.

Judging from what is known of other species of Aphides whose history has been more continuously studied, we may conclude that the eggs, by means of which these insects are perpetuated through the winter, are deposited by the last brood of impregnated females, late in the season. Strange to relate, these eggs produce fertile females, which in due time, produce living young, without having had any union with the other sex, and this process is capable of being continued through a number of successive generations. Ordinarily, and perhaps always, in the state of nature, male individuals are produced before the close of the season; but the experiments of Kyber, as quoted by Westwood, show that under certain artificial conditions, this process of reproduction without the male influence, may be continued through a number of years.

The facts observed in the life history of the gall-making Aphis of the poplar leaf, render it altogether probable that this species is propagated essentially in the same manner. We uniformly find in these galls, in their incipient stages, a solitary wingless individual which, later in the season, becomes greatly distended, and in due time is found surrounded with a numerous progeny. We have never discovered any eggs of the Aphis in the cells, nor have we been able to detect any distinctly formed ova in the bodies of the distended females, from which we conclude that, like many other species of Aphides, they bring forth their young alive.

The young lice are of a pale-greenish color, with the tips of their abdomens covered with a cottony secretion. By the first of June some of

them exhibit the rudimental wing-cases upon their backs, which show that they have passed into the pupa state, and by the middle of this month, most of them have become developed into perfectly winged individuals, changing at the same time from pale-greenish to a dingy blue-black color. We will not occupy space by a minute description of these insects, inasmuch as, like the majority of gall-making insects, they are much more easily recognized by the size, shape, and situation of their galls, than by minute details of their own structure.

Like other insects with wingless females, this species is much restricted in its range, and it is common to see some trees damaged by them and others not, though growing side by side. The infested trees are easily distinguished from the others, at a distance, in the latter part of the season, by the faded and yellow color of the foliage, especially on the lower branches.

If the lips which form the mouths of these galls be drawn apart, any time in the month of June, and usually through the greater part of July, they are found to be filled with lice in all the stages of their growth, seeming to show that there must be a continuous generation of them, or that the different broods interlock with each other. I have found galls thus occupied even as late as the middle of August.

In the same cavity, and intermingled with the insects, are usually to be seen a considerable number of little spherical globules, varying from the size of a very small pin-head to that of a very large one, sometimes lying lose in the cavity, and at other times attached to the bodies of the young lice, and usually adhering to the tips of their abdomens. When one of these galls is opened, its crowded population are evidently much agitated by the unwonted admission of light. Whilst watching them attentively at such times, I have seen the curious spectacle of the little globules flying out of the cell with such rapidity that the eye barely caught a glimpse of them as they passed. I observed them closely for a considerable time before I could get any clue to the mechanicism by which this phenomenon was produced; but I concluded that it was caused by a jerking motion of the legs of the young lice. The difficulty of determining this point lay in the suddenness and rapidity of the motion, and the impossibility of knowing beforehand upon which globule to fix the attention.

These globules are composed of a limpid fluid, not distinguishable from water, covered with a film so exceedingly delicate that when shaken out of the cell upon a hard surface, they break from their own weight. Whether these globules occur in other galls I am unable to say, but I have seen similar bodies in the cavities caused by the folding of the edge of the leaf of the persimmon, produced by a species of Psylla.

The origin and nature of these globules, and the part which they fulfill in the economy of the insect, are matters of conjecture. We do not know, with certainty, whether they originate from the insect itself, or from the inner surface of the gall. The most plausible supposition is that they are secretions from the bodies of the insects, probably from their anal extremity, and that they bear some analogy to the drops of sacharine fluid secreted from the honey-tubes of the true Aphides.

The mouths of these galls do not close so closely, at least in the latter part of the season, as to exclude a variety of predaceous and parasitic enemies, by which their numbers are greatly reduced. If we examine them in the latter part of July and subsequently, we often find but few lice remaining, and in their place some one or other of their natural enemies. I have found within them minute, black, four-winged flies of the Chalcis family. Also, the larvæ of some small, two-winged Syrphus fly, known by their oblong, pear-shaped form, tapering to a point anteriorly, and their snake-like manners. These larvæ appear to be blind, and they discover their prey by moving their pointed anterior extremity from side to side. I have also seen a considerable number of greenish-yellow, semi-pellucid grubs, of a short ovoid form, abruptly pointed posteriorly, apparently too large to be the larvæ of the Chalcides, and being more probably the larvæ of some species of Ichneumon fly.

But their most common destroyer is a small Hemipterous insect belonging to the genus Anthocoris, and closely allied to, if not identical with, the *Anthocoris musculosus* of Say. From one to half a dozen of these predaceous insects are often found in one of these galls in the latter part of the season. The fully matured insects are one-eighth of an inch long, and are of a glossy-black color, with brown and white wings. The young larvæ are scarlet-red.

PRACTICAL REMARKS ON THIS AND OTHER SPECIES OF APHIDES.

The extensive family of Aphides, viewed with respect to their modes of life, may be divided into four sections.

First. The *leaf-lice* or Aphides proper, distinguished by their long, tapering seven-jointed antennæ, and the honey-tubes on their abdomens These live on the leaves both of trees and herbaceous plants, or on the tender growth of the current year. They are diffused upon almost all kinds of vegetation, and those subsisting upon different kinds of plants are often so much alike in their organic characters as to render it doubtful whether they are different species, or mere plant-varieties of the same. The Aphides are very tender insects and are often extensively destroyed by sudden changes of the weather. The most troublesome variety is that which infests hot-houses, where they luxuriate in the artificial protection and warmth provided for the plants. The common

remedy for them is the fumes of tobacco. It is a good plan to apply the tobacco-smoke two or three successive days, as one exposure to it is often found to stultify without killing the insects.

Second. The *twig-lice*, comprising the several species of the genus *Lachnus.* These are distinguished by their six-jointed antennæ, the honey-tubes very short or merely rudimental, and by their usually dotted abdomens. These are found in flocks on the smaller limbs of the hickory, the willow, and probably other trees. We have seen them on young apple trees, but in this instance it was evident that they had migrated thither from some neighboring willows. With this accidental exception we believe the species of this genus have not been found on any of our fruit trees.

Third. The *root-lice*, belonging to different genera, with the antennæ still shorter, and the honey-tubes wholly wanting. These infest the roots of plants, often causing their death, and they are therefore much more serious pests than any of the other kinds. The root-lice which infest the roots of young apple trees (*Eriosoma Pyri*) and those found upon the roots of the grape vine, (*Phylloxera vitifolii,*) are the most important species in this section. Both of these species are much more abundant in the southern than in the northern half of the State. The best preventive of the spread of these insects is to examine the roots of young trees or vines when taken up for the purpose of transplanting, and if found to be infested by the root lice, to immerse them for a few minutes in hot soapsuds or tobacco water. The presence of the lice is often first detected by the swellings or knots upon the roots which the lice produce.

Fourth. The *gall-lice*, or more definitely, the gall-making Aphides, for galls are also made by other insects, to some of which, especially the gall making *Acari* or *mites*, the term gall-lice would be still more appropriate.

To this section belongs the species which is the subject of this article. It is evident that gall insects, like those which inhabit the substance of our fruits, must be very difficult to contend with, for the reason that our destructive applications cannot ordinarily be made to reach them, and yet, if we carefully trace the history of almost any noxious insect through its whole career, we can generally discover some one more weak or exposed points in which they become subject to destructive agencies.

Fortunately the gall-making Aphides have not as yet seriously infested any of our fruit bearing trees, with the exception of those found on the leaves of the Clinton grape vine. Galls in great diversity render unsightly the foliage of many forest and ornamental shade trees, but as a general rule they are not sufficiently numerous to interfere materially with the health and growth of the trees. This rule, however, has its exceptions,

as in the case of young elm trees infested with the cock's-comb gall, and the cotton-wood sometimes has quite a sickly aspect from the profusion of the galls now under consideration.

It is one of the admirable provisions of nature that those insects which are stationary the greater part of their lives, such as the scale-insects, and the gall-insects, not only select, with wonderful discrimination, each its own particuliar kind of tree, but in some instances different insects, and sometimes even closely allied species, exhibit a strong predilection for some particular part of a tree, and different from that selected by others. For example, the scale insects of the genus *Mytilaspis*, to which the oyster-shell bark-louse of the apple tree belongs, are generally found much the most abundantly on the lower branches. This is exemplified by the apple bark-louse, and still more strikingly by the *Mytilaspis* of the pine. In curious contrast with this is the habit of a closely allied species, specimens of which were sent to me by Prof. Uhler, of Baltimore, which were found upon the ornamental linden trees in that city, and which were so exclusively confined to the upper portions of the trees, that he obtained his specimens only from branches which had been brought to the ground by pruning.

A similar distribution of species occurs, as we have already had occasion to observe, in the gall-making Aphides of the cotton-wood, one of which (the *vagabundus*) is often seen upon the topmost twigs, whilst the species now under consideration (the *populicaulis*) is mostly confined to the lowest branches. This is only one exemplification of the law of diffusion of species, in nature, whereby all parts of her domain become peopled by living and sentient beings. It is evident also that this localization of particular species may sometimes afford us important practical suggestions by giving to our remedial measures a more definite aim. When the insect to be combatted locates itself, as in the present instance, upon the foliage of the lowest branches, the obvious suggestion is to reduce the field of operations by cutting them away, or stripping off the leaves where it is important to save the branch.

With respect to the above classification of the Aphides in accordance with their habits and modes of life, it is proper to remark that it must be regarded as one of practical convenience rather than of scientific accuracy. This follows, from the fact that we sometimes find in the same genus, as in that of *Eriosoma*, species which vary greatly in this respect; and in other cases, as in the gall-louse of the grape leaf, (*Phylloxera vitifolii*,) it is now pretty well determined that the same species may form and inhabit galls at one period of its life, and at another migrate to the roots.

TRANSPORTATION OF USEFUL PARASITIC INSECTS.

The idea of rearing the useful parasitic insects, and of transporting them, when necessary, from one part of the country to another, has often presented itself to practical entomologists, and was a favorite topic of speculation of my predecessor in office, B. D. Walsh. But the very small size of most of these insects, many of them, indeed, being so minute that they cannot be easily seen without the aid of a lens, and the consequent difficulty of manipulating them, have always given a somewhat chimerical aspect to the suggestion, and have caused it to be regarded as more ingenious than practicable.

In the course of our investigation of the Oyster-shell Bark-louse of the apple tree, in the year 1870, we discovered a minute Chalcis fly, which we designated as the Chalcideous parasite of the Oyster-shell Bark-louse, *(Chalcis [Aphelinus] mytilaspidis)* which was found to be extensively instrumental in extirpating that deadly enemy of the apple tree, by boring into the scale and depositing her own egg in the body, or in the midst of the eggs of the Bark-louse. The parasitic larvæ which hatched from this egg lived at the expense of the Bark-louse and its eggs, and thus caused their destruction. It was found that in several of the counties of this State where the examinations were made, that more than half of the bark-lice had been destroyed by this parasite, its operations being known, partly by the presence of the little grubs beneath the scales, and partly by the minute round holes in the scales, through which the Chalcis-flies had escaped. It was also found, by examining the scales late in the fall, that one brood of the Chalcides hibernated in the larva state beneath the scales. The idea, therefore, readily occurred that this was a very favorable opportunity for testing the practicability of transporting these friendly parasites to those parts of the country in which their presence cannot now be detected. We had previously received several packages of apple twigs from different localities in the northern part of Illinois and the southern part of Wisconsin, heavily infested with the scales of the Bark-louse, but

without any traces of the parasitic Chalcides, and this section of country seemed therefore to furnish a favorable field in which to try the experiment of colonization.

Captain Edward H. Beebe, of Galena, who had been passing the winter in Geneva, and who had taken a lively interest in this investigation, undertook to conduct this interesting experiment. Early in the spring of 1871, on his return to Galena, he took a package of twigs, which we had procured from trees known to have been inhabited by the Chalcides, and under some of the scales upon which it was therefore probable that the larvæ were hibernating. These he tied upon trees in three different orchards, in the town of Galena, which were known to be badly infested by bark-lice.

When we consider the minute size of these insects, the fully matured fly being only one twenty-fifth of an inch in length, and that the hole in the scale of the bark-louse which reveals the operation of the Chalcis is so minute that it can only be seen by the aid of a magnifying glass; and we further take into account that probably less than a dozen of these larvæ were transported to the new locality, and that the small number of parasitic flies proceeding from these were let loose in three orchards containing many hundreds of apple trees, we may form some idea of the difficulties of this experiment, and of the uncertainty which would be likely to attend any observations made for the purpose of determining the presence of the Chalcides. Even if the experiment should prove ultimately successful, it would be very doubtful whether the Chalcis marks would be sufficiently numerous to be detected at the close of the first year, but after this they would be likely to multiply in a rapidly increasing ratio.

About the last of May, 1872, that is, after the intervention of one year from the time of commencing this experiment, Capt. Beebe examined some of the trees to which the Chalcis twigs had been attached, and after a careful search thought that he had discovered a few traces of the operations of the Chalcides, and sent half a dozen of the twigs bearing these marks to me for inspection. We may here state for the information of those who have not seen our former articles upon this subject, that the scales of the bark-louse are found to be damaged by two very different kinds of insects, namely, the larvæ of the Coccinellidæ or lady-bugs, which gnaw ragged holes through the scales for the purpose of obtaining and devouring the lice beneath, and the minute parasitic Chalcis flies, of which we are speaking, which cut perfectly clean and round holes, for the purpose of escaping from the cell, in which, after devouring the rightful occupant, they have undergone their transformations. Upon the selected twigs were found some marks of the Coccinellidæ, and also a few holes, about one to each twig, which were

so round and smooth that they could not be fairly attributed to any other source than to some species of Chalcis; but as they were a little larger than the holes made by the minute species with which we were experimenting, we were unable to arrive at a definite conclusion.

On the 13th of July, I visited Galena, and in company with Captain Beebe, submitted one of the trees, to which the greatest number of the twigs had been attached, to a thorough examination.

The result, if not actually conclusive, was at least extremely encouraging. We detected a considerable number of holes in the scales, which appeared to be identical, in every respect, with those made by the Chalcis in question, and in one instance we discovered three of these holes upon the same twig, within a space of four inches.

In conducting an experiment of so delicate a nature I am well aware that the greatest caution must be exercised to avoid jumping to hasty conclusions, and that the observations of a number of succeeding years will be necessary before we can arrive at a definite conclusion that the experiment has been followed by a practical, as well as a scientific success.

At the close of the author's article upon the Oyster-shell bark-louse, in his first annual report, after speaking of the absence of any signs of the Chalcides, in the northermost part of the State, and of the possible practicability of transporting them thither, we concluded with the following remark:

"The absence of the Chalcis of the bark-louse, in this locality, will furnish an excellent opportunity for testing the practicability of transporting it thither from those places where it is known to exist. If, after taking the preliminary steps, as described in a former part of this article, we should find, after the lapse of the necessary time, upon the trees experimented with, the characteristic holes in the scales which mark the exit of the Chalcis, we would know that the friendly parasite had entered upon its work. If such an experiment could be conducted to a successful issue, it would furnish one of the most admirable instances on record, of the triumph of science, in its application to economic entomology."

OUTLINES OF ENTOMOLOGY.

INSECTS IN GENERAL.

Insects constitute the most numerous and diversified class of the second grand division of the animal kingdom, designated by the term ARTICULATA, and so called because their bodies and limbs are composed of many pieces, connected together by movable joints or articulations.

Insects as a class, and in the widest meaning of the word, comprise three divisions, or sub-classes, commonly known as Spiders, Insects and Millipedes. They may be distinguished by the following characters:

1st. Sub-class: ARACHNIDA, including Spiders, Scorpions, and Acari or Mites. Body divided into two parts, the head and thorax being united in one; legs eight in number; without wings.

2d. Sub-class: INSECTA, or Insects proper. Body divided into three parts, the head, the thorax, and the abdomen; legs six; furnished with wings, in the perfect or *imago* state.

3d. Sub-class: MYRIAPODA, commonly called Millipedes or Centipedes. Body divided into many parts or segments, varying from ten to two hundred; legs numerous; usually either one or two pairs of legs to each segment of the body; never have wings.

The exceptions to these characters are very few. In the Arachnida, some of the most minute Acari have but six legs.

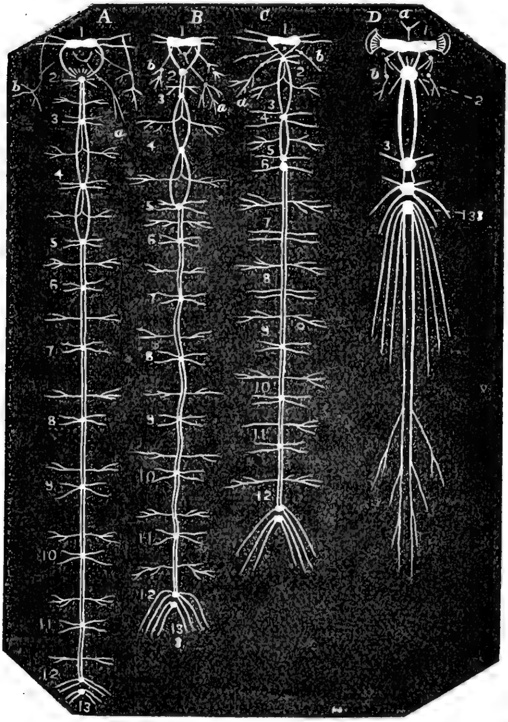
Insects proper are always six-legged in their last or perfect state, and they also generally have six true legs in their larva state; but some larvæ have no legs, and the larvæ of the Lepidoptera, commonly called caterpillars, have, in addition to their six true legs, several pairs of false legs, or pro-legs, which assist in locomotion.

There are a few exceptional cases in which insects are destitute of wings. The Fleas (Pulices), the Lice (Pediculi), and the little family of insects known as Spring-tails (Thysanoura), never have wings. In some rare instances the females are wingless whilst the males have wings. This is the case with some species of the Lightning-beetles (Lampyridæ), and with the Canker-worm moth, and the Tussock-moth, and a few other species amongst the Lepidoptera. Similarly exceptional cases are also found in other orders of insects.

The present work will treat only of Insects proper.

INTERNAL STRUCTURE OF INSECTS.

THE NERVOUS SYSTEM.



Nervous system of insects. Explained in the text.

The nervous system of insects consists of a double cord extending the length of the body, and lying upon the inferior or ventral side of the internal cavity. The two threads which compose this cord do not lie side by side, but one above the other. The lower thread swells at intervals into little knots of nervous matter, called ganglia. In insects of an elongated form, such as some of the Neuroptera (e. g. Corydalis), and the larvæ of the Lepidoptera, there is a ganglion at each segment of the body, making thirteen in all; but in most mature insects the ganglia become more or less consolidated. In the Butterfly (Papilio), there are ten ganglia, counting the brain as one; in the Bee (Apis), there are eight; in the May-beetle (Melolontha), there are five; and in the Cicada there are but two. The upper of the two nervous threads runs nearly in contact with the lower, but is destitute of ganglia. These two threads seem to represent the double and more compact cord which constitutes the spinal marrow of the higher or vertebrated animals. The upper simple thread is supposed to furnish the nerves of motion, and the lower and ganglionic thread, the nerves of sensation. The fibres which compose these cords separate at the anterior extremity of the body, so as to embrace the œsophagus or gullet, above which they again unite to form the cerebral ganglion or brain, which is somewhat larger than the other ganglia. From the nervous cords, and chiefly from the ganglia, fine lateral threads are emitted, which are distributed to the adjacent parts.

The nerves thus far described represent what, in the higher animals, is called the cerebro-spinal system of nerves, and are sometimes called

the nerves of relation, because they control the sensations and motions which associate the animal with the world around it. But in addition to these, there have been discovered a number of very fine nervous filaments proceeding from the brain, and extending down into the body, and furnished with minute ganglia of their own, which are supposed to represent the sympathetic system of nerves which preside over the internal functions, such as those of digestion and secretion.

The foregoing cut represents the nervous system of a butterfly, (*Papilio brassicæ*) (after Herold), A exhibiting that of the larva, B that of the pupa, and C that of the perfect insect; and showing how the nervous system becomes shortened and consolidated in changing from the lower to the higher stages. Fig. D shows the more concentrated nervous system of a Coleopterous insect, as exhibited in the common English Cockchafer or Door-beetle, *Melolontha vulgarus;* (copied from Straus.)

THE CIRCULATORY, OR SANGUIFEROUS SYSTEM.

The blood of insects is a colorless fluid which does not circulate in closed vessels or tubes, like that of the higher animals, but permeates the tissues of the body. The only vessel that can be discovered, is an oblong, membraneous, pulsating sac, situated in the upper or dorsal part of the body, and which evidently represents the heart. This is divided into several compartments by cross-valves which are so arranged as to permit the blood to pass only in a forward direction. The heart is prolonged anteriorly into a narrower tube analagous to the aorta. Through this the blood flows first towards the head, and thence through the body, returning to the heart which it enters through openings at its sides. As compared with that of the warm-blooded animals, the blood of insects is not only colorless, but small in quantity, and must circulate very slowly, as is proved by the fact that when their bodies are wounded no blood escapes.

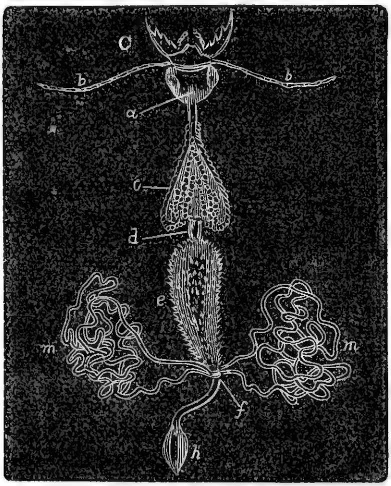
THE RESPIRATORY SYSTEM.

Most of the organs of insects, and their functions, have an obvious analogy to those of the higher animals, but their breathing apparatus is constructed upon an entirely different plan. In all the vertebrated animals the blood is carried in vessels to a particular part or organ of the body, for the purpose of being exposed to the life-giving influence of the air. This part, in terrestial animals, is the lungs, and in aquatic animals, the gills. But in insects the process is reversed, and the air is carried to the blood by being distributed to every part of the body in very delicate pearl-white tubes or vessels, which present a beautiful appearance under the microscope. They are called tracheæ, or air tubes. They admit the air through little openings along the sides of the in-

sect's body, called spiracles. The spiracles or breathing-pores can be easily seen along the sides of all caterpillars which are not too densely covered with hairs. In the perfect or winged state of insects the branches of the air tubes are dilated into a great number of little vessicles or air bladders, which render their bodies lighter, and thus facilitate their flight.

In some aquatic larvæ the tracheæ project from the body in the form of little tufts, analagous to the gills of fishes. The aquatic beetles are under the necessity of rising to the surface, at intervals, for air, in a manner similar to that of the aquatic mammalia, the whales and the dolphins.

THE DIGESTIVE OR NUTRITIVE SYSTEM.



Digestive organs of insects explained in the text.

The digestive apparatus of insects, like that of other animals, consists of an elongated tube called the alimentary canal, extending through the body, and having a number of enlargements in its course, and in many insects presents a particular resemblance to the digestive apparatus of birds. First, there is a short, straight œsophagus or gullet; this expands into a much larger cavity resembling the crop; then follows a smaller muscular part, analagous to the gizzard; and next, a much larger and longer cavity which is the true digestive stomach; this becomes contracted into the intestinal canal, which sometimes runs nearly straight through the body, and in other cases is more or less convoluted; the intestine enlarges again before it reaches the end of the body into what is known as the large intestine, or colon. As in other animals, the alimentary canal is much longer and more capacious in the herbivorous than in the carnivorous kinds. As a general rule the canal is much more capacious in the larva than in the imago state.

The figure, *C*, represents the digestive organs of one of the carnivorous beetles, *Cicindela campestris*. *a* the commencement of the œsophagus or gullet; *c* the crop; *d* the gizzard; *e* the stomach or principal digestive cavity; *f* the commencement of the small intestine; *h* the large intestine; both of these parts are unusually short in this tribe of insects; *m m* the convoluted vessels which are supposed to represent the liver of the higher animals.

THE SECRETORY SYSTEM.

The secretory apparatus of insects, though analagous in function, is very different in appearance from that of the higher animals. Instead of solid glands, like the liver or kidney, it has the form of masses of convoluted tubes, as represented at *m* in the preceding figure. The salivary glands, the liver, the kidneys, and the testacles are found represented in insects. The gastric and pancreatic fluids are secreted by little cells or follicles in the coats of the stomach.

THE MUSCULAR SYSTEM.

The muscles of insects, like those of other animals, consist of contractile fibres, but in their situation and attachments, as compared with those of the vertebrate animals, they are reversed; that is to say, in the latter, the muscles are situated outside of, and upon the bones, which constitute the supporting part of the body, whereas in insects, the supporting part is the external crust, and the muscles are attached to its internal surface. The muscles are of a pale yellowish color, and are usually presented in the form of thin layers, and sometimes of isolated fibres, and are never united into the rounded compact form, which they have in the higher animals. By counting the separate fibres a very great number of muscles have been enumerated. Lyonet counted nearly four thousand in the larva of *Cossus ligniperda*, and Newport found an equal number in the larva of *Sphinx ligustri*. The muscles of insects possess a wonderful contractile power in proportion to their size. A flea can leap two hundred times its own length, and some beetles can raise more than three hundred times their own weight. This remarkable strength may probably be attributed to the abundant supply of oxygen by means of the myriad ramifications of the air tubes.

THE ORGANS OF THE SENSES.

Insects are evidently endowed with the ordinary senses which other animals possess, but no special organs of sense, except those of sight, have been discovered with certainty.

Sight.—The eyes of insects are of two kinds, simple and compound. The simple or single eyes are called *ocelli*, and may be compared in appearance to minute glass beads. They are usually black, but sometimes red, and are generally three in number, and situated in a triangle on the top of the head. In insects with a complete metamorphosis, these are the only kind of eyes possessed by them in their larva state, and in these they are usually arranged in a curved line, five or six in number, on each side of the head. We have noticed that in some insects which undergo only a partial metamorphosis, as for example the common

Squash-bug *(Coreus tristis)*, the ocelli are wanting in the larva and pupa states, but become developed in the last or perfect stage.

The compound eyes of insects present one of the most complex and beautiful mechanisms in the organic world. They are two in number, but proportionately very large, occupying in many insects nearly the whole of the sides of the head, and in the dipterous order especially, often present across their disks, bands of the richest tints of green, brown and purple. These eyes are found to be composed of a great number of lesser eyes or eyelets, in the form of elongated cones so closely compacted as to form apparently a single organ. The larger ends of these cones point outwards, and by their union form the visible eye. Their smaller extremities point inwards, towards the brain, to which they are connected by means of a large optic nerve. When one of these eyes is examined through a strong magnifying glass, it is seen to be composed of a very great number of little facets, sometimes square, but usually six sided, each one of which represents the outer and larger extremity of one of the component parts. These facets vary greatly in number in the eyes of different kinds of insects. In the ants there are about fifty in each eye; in the Sphinx moths, about 1,300; in the house fly, 4,000; in the butterfly, upwards of 17,000; and in some of the small beetles of the genus Mordella, it is said that more than 25,000 facets have been enumerated in one compound eye; so that if we suppose that each of these component parts possesses the power of separate vision, one of these insects must have more than 50,000 eyes. How vision is effected, or how a unity of impression can be produced by so complex an organ, we are unable to conceive.

Hearing.—Insects are evidently affected by loud noises, and moreover, as many insects have the power of producing voluntary sounds, it is reasonable to suppose that they possess the sense of hearing. No organ, however, which has been generally admitted to be an organ of hearing, has been discovered. It is the most common opinion of entomologists that the antennæ are instrumental in receiving the impressions of sound, and that the sense of hearing is located at or near their place of attachment to the head, and this view is much strengthened by the fact that in some of the larger crustaceans, such as the lobster and crab, a distinct organ of hearing is found located at the base of the antennæ.

Smelling.—That insects are endowed with the sense of smell, is proved by the fact that the carrion-fly, and other insects which feed upon, or deposit their eggs upon, putrescent matter, detect such substances a ta distance, however completely they may be hidden from the sight. The bee also discovers honey under similar circumstances, and it is therefore fair to presume that insects are conducted to flowers, in hidden situa-

tions, more by their odor than by their visible characters. But no organ of smelling has been discovered, and this sense is supposed, from analogy, to be located in the lining membrane of the spiracles.

Taste and Touch.—It is impossible to determine, but there is no reason to doubt, that insects, like other animals, taste and enjoy the food of which they partake; and the manner in which they frequently touch their food and the surfaces over which they walk, with the tips of their palpi, which, indeed, have received the common name of *feelers*, renders it probable that these organs are endowed with a special sense of touch.

SOUNDS PRODUCED BY INSECTS.

The songs of birds, and the noises made by other animals, are produced by the forcible passage of air through the glottis, which is the narrow opening at the top of the wind-pipe, aided by the vibration of certain muscular folds near the outlet, called the vocal chords. But we have seen that insects never breathe through their mouths, and therefore they never make any oral sounds. But the humming of bees and flies is produced in an analogous manner, by the expulsion of air through the thoracic spiracles, and the vibration of a delicate valve-like fold, just within the opening.

But besides this, insects make a variety of noises, which are produced in different ways. The singing of the Cicada, which is the loudest noise made by any insect, is produced by the expulsion of air from the first abdominal spiracle, striking upon a large transparent drum-like apparatus, situated at the base of the abdomen. The chirping of crickets is produced by rubbing together their parchment-like wing-covers. The well known noise of the katy-did is produced in the same way, but here the sound is intensified by a thin talc-like plate set into the base of each wing-cover. The stridulation of grass-hoppers is caused by the friction of their spined shanks across the edge of their wing-covers. The fainter, squeaking sounds, made by many insects when captured, are produced simply by the rapid friction of one part of their bodies upon another; in certain Hemiptera, by the friction of the head upon the pro-thorax; in the Capricorn beetles, by the friction of the pro-thorax upon the meso-thorax; and in some of the Lamellicorn beetles, by the friction of the abdomen against the wing-covers.

The more complex and special apparatuses of insects for the production of sounds, are possessed exclusively by the males, and are supposed to be exercised by them as calls to the opposite sex, but the simpler squeaking sounds are emitted by both sexes, and appear to be mere notes of alarm.

THE METAMORPHOSES OF INSECTS.

Nothing in the history of insects is more remarkable than the striking changes of form which many of them undergo, in the course of their development. Whilst other animals progress from infancy to maturity simply by a process of growth, and by such gradual and imperceptible changes only as their growth necessitates, many insects assume totally different forms in the course of their development, so that they could never be recognized as the same individuals, if this development had not been actually traced from one stage to another. These changes are called the *metamorphoses* or *transformations* of insects. All insects, in their growth, pass through four stages, designated as the *egg* state; the *larva*, or caterpillar state; the *pupa*, or chrysalis state; and the *imago*, or perfect and winged state. The metamorphoses of insects are of two principal kinds, *complete* and *incomplete.*

In the *complete* metamorphosis the larva bears no resemblance to the imago, and the insect, in the intermediate or pupa state, is motionless, and takes no food. This kind of metamorphosis presents two principal varieties. In some (Lepidoptera and many Diptera), the legs and wings are completely inclosed in the pupa case. In others (Coleoptera, Hymenoptera, and some others), the legs of the pupa, though useless, are free, and the rudimental wings lie loosely upon the sides. Moreover, in some (the nocturnal Lepidoptera, and many Hymenoptera), the pupa is inclosed in a separate covering or cocoon, whereas the majority of insects have no such covering. Pupæ thus inclosed are called *folliculate.* The term *chrysalis*, from a Greek word meaning *golden*, is sometimes applied to the pupæ of the diurnal Lepidoptera, because the pupæ of some butterflies are ornamented with golden spots.

Most insects, in changing from the larva to the pupa state, cast off the larval skin, but in many of the two-winged flies, (Muscidæ, Syrphidæ, etc.) the larval skin becomes contracted and hardened, assumes an oval form and a brown color, and thus forms a compact and closely-fitting case, in which the pupa proper is inclosed, but distinct. Pupæ thus inclosed are called *coarctate*, and their cases are analogous to the cocoons of the Lepidoptera.

In the *incomplete* metamorphosis, the insect presents essentially the same form, and is active in all its stages, after leaving the egg. The pupa is distinguished from the larva by the presence of short rudimental wings at the base of the abdomen, and the imago or adult state is distinguished by the fully grown wings and wing-covers. It is only in this last stage that insects are capable of propagation. All the Hemiptera, or bugs proper, and all the Orthoptera, or crickets, grasshoppers and cockroaches, exhibit this imperfect kind of metamorphosis.

In treating of the development of insects it is necessary to refer to the periodical casting of the larval skin. All the growth of insects takes place in the larva state. Consequently no insect increases in size after it has acquired wings. The larval skin seems to be an imperfectly organized membrane, which does not correspond in its growth to that of the body, but yields to this growth, to a certain extent, by virtue of its elasticity. A time comes therefore when it can yield no farther. The insect then evidently becomes oppressed, ceases to eat, usually retires to some secluded spot, and, if gregarious, huddles together with its companions, and there remains a day or two, almost motionless and without food, and in an apparently torpid and sickly condition. After a time the distended skin bursts open, and the insect throws it off, and appears in a new, bright, and elastic skin, which, in its turn, is capable of a certain degree of distension. This process, which is called *moulting*, takes place three or four times in the course of the larval growth, and in a few larvæ which continue more than one year in this state, the moulting is said to occur from five to eight times. In insects of very rapid development, on the other hand, such as the maggots, or larvæ of the Muscidæ, no moulting takes place, and it is the larvæ of this kind which form coarctate pupæ.

THE SEXES OF INSECTS.

As a general rule insects of different sexes resemble each other so closely as to leave no doubt of their specific identity, and in many the sexes can scarcely be distinguished. But this rule is subject to many exceptions, and the naming of insects has been greatly confused by the sexes of the same insect having been described and named as distinct species.

The sexual organs, especially those of the males, are usually concealed so as to be nearly or quite invisible; but the female, especially in the order of Hymenoptera, often have an exserted ovipositor of greater or less length, which readily distinguishes them from the opposite sex. An analogous structure exists in many wood-boring beetles which deposit their eggs in deep crevices in the bark of trees; and more rarely in insects of the other orders. In the Coleoptera the males are sometimes distinguished by one or two horns, either upon the head or thorax, and many of the predaceous beetles, both terrestrial and aquatic, have the anterior feet much widened, and furnished beneath with a cushion of hairs or bristles.

The antennæ usually differ in length but little, if at all, in the two sexes; but in the long-horned beetles (Cerambycidæ) the antennæ of the males are generally considerably longer than those of the females.

In those moths which have bi-pectinate antennæ, these parts are almost always wider in the males. Many insects in the order of Diptera are remarkable for the great size and beauty of their eyes, and these organs are almost always larger in the males than in the females.

♂ male. ♀ female. In describing insects it is customary, for the sake of brevity, to distinguish the sexes by signs, as shown in the margin.

EXTERNAL STRUCTURE OF INSECTS.

The clasification of insects depends chiefly upon the structure of the external and visible parts. It is necessary therefore that the student should have a thorough knowledge of these parts and of the names by which they are designated. But as these parts are very greatly modified in the different orders of insects, we shall reserve a minute discription of them till we come to treat of them in connection with the several orders respectively, and shall here give only a general enumeration of them. The student will be much aided in understanding the following description by comparing it with the figure of *Harpalus caliginosus* on a subsequent page.

THE HEAD AND ITS APPENDAGES.

It often becomes necessary to refer to different parts of an insect's head, and they are therefore designated by particular names indicative of their situation. These are—

The Hind-head, (*Occiput*). The Crown, (*Vertex*). The Fore-head, (*Frons*). The Face, (*Facies*). The Cheeks, (*Genæ*).

The appendages of the head are the Horns (*Antennæ*); the Eyes, (*Oculi*); and the parts of the Mouth, (*Trophi*, or *oral organs.*)

The *Antennæ.*—All insects have two more or less elongated and usually many-jointed antennæ, situated one on each side of the head, and varying greatly, in different kinds of insects, in length and in the form of their component joints. Insects have very short antennæ in their larva state, and in some perfect insects, such as the water-beetles, (*Gyrini* and *Hydrophili*), the antennæ are not longer than the head, whilst in others, such as some of the longicorn beetles, they are more than twice as long as the whole body, and in some of the small moths of the genus *Adela*, they are five or six times as long. The uses of the antennæ are not known, but, as we have stated above, when treating of the senses of insects, they are supposed to be instrumental in the sense of hearing. The most common variations in the forms of the antennæ are expressed by the following terms. Figures of most of these forms are given on a subsequent page, in treating of the Coleoptera.

Filiform, or *thread-like;* long and slender, and of the same, or nearly the same width throughout.

Setiform, or *setaceous; bristle-like;* long and slender, but tapering towards the tip.

Moniliform, or *bead-like;* when the joints are of about the same size, and round, so as to resemble a string of beads.

Serrate, or *saw-toothed;* when each joint is somewhat triangular, and a little prominent and pointed on the inner side.

Pectinate, or *comb-toothed;* when the inner angles of the joints are considerably prolonged.

Bi-pectinate, or *double comb-toothed;* pectinate on both sides.

Clavate, or *club-shaped;* gradually enlarging towards the tip.

Capitate, or *knobbed;* when a few of the terminal joints are abruptly enlarged.

Lamellate; when the joints which compose the knob are prolonged on their inner side, in the form of plates.

The *Eyes.*—We have briefly discribed the mechanism of the eyes when treating of the sense of sight. They are uniformly of a round or oval shape, and sometimes notched on their inner side, to give place for the insertion of the antennæ. In a few instances they are placed at the end of foot-stalks made by a lateral prolongation of the head.

The *Trophi*, or parts of the mouth.—The mouths of insects present two strongly marked variations, one of which is fitted for gnawing solid substances, and is called the *mandibulate*, or gnawing mouth; and the other is fitted for sucking fluid nutriment, and is called the *haustellate*, or suctorial mouth.

The mandibulate mouth is composed of six pieces, more or less distinct, and their appendages. First, the *labrum*, or upper lip: a horny, usually somewhat semi-circular plate, attached to the anterior and inferior edge of the head, and serving to close and protect the mouth in front.

Then, the *Mandibles*, or upper jaws; a pair of very hard, horny pieces, more or less hooked at the point, and often toothed on their inner sides, which work together laterally, somewhat like the blades of a pair of scissors. These are the true biting, gnawing, or masticating organs.

Next are the *Maxillae*, or lower jaws; a pair of organs, working laterally like the mandibles, but softer and more pliable in their texture, generally divided into two lobes at their extremity, which are furnished more or less with hairs. The maxillae undoubtedly assist in the operation of eating, but the precise part which they perform is not well understood.

Behind the maxillae is a single piece which partially closes the mouth behind, and which may therefore be considered as the counter-part of the labrum or upper lip, and is accordingly called the *labium* or lower lip.

In the Coleoptera this piece is usually attached at its base to the anterior face of an elevated ridge upon the under side of the head, which

forms a kind of wall behind the mouth, usually deeply notched in the middle, and which is called the *mentum*, or chin.

When the labium forms a narrow elongated piece, distinct from the mentum, as in most of the Coleoptera, it is now generally called the tongue, *lingua* or *ligula*.

The *Palpi*, or appendages of the mouth.—Near the base of each maxilla, on its outer side, is attached a moveable appendage, usually composed of four or five joints, and never more than six, called the *maxillary palpus;* and near the base of the labium is attached a similar pair of organs, but with a less number of joints, distinguished as the *labial palpi.* These appendages are subject to considerable variation, especially in the shape of their terminal joints, and are made much use of in determining the families and genera of insects.

The *haustellate* or *suctorial* mouth consists of a more or less elongated proboscis or sucker, which is sometimes short and fleshy, as in the flies, (*Muscidae;*) sometimes more elongate, horny and pointed, as in the bugs, (*Hemiptera;*) and sometimes very long and slender, and rolled up, when not in use, in a spiral coil, as in the butterflies and moths, (*Lepidoptera.*)

It is evident that all insects with a suctorial mouth must live exclusively upon liquid food, or the juices of animals and plants.

The *haustellum* or sucker is not a single organ, as it appears, but has upon its upper side a deep groove, in which are contained usually either two or four, but in some of the carnivorous species (mosquitoes and horse-flies) six needle-shaped pieces, which in these last make a complicated weapon with which they pierce the skins of animals upon whose blood they subsist.

From a comparison of the haustellate with the mandibulate mouth, in different kind of insects, it has been concluded that the apparent sucker, which, as we have just seen, forms a sheath for the smaller needle-shaped pieces, corresponds to the labium, and that the contained pieces must represent the mandibles and maxillae, and, where six pieces are present, also the labrum and lingua. In accordance with the proportionately great development of the labium, we find that its appendages, that is, the labial palpi, are also very prominent, whilst the maxillary palpi are very small or rudimental. This is the case in two of the suctorial orders, the Lepidoptera and Diptera; but the other order (Hemiptera) is exceptional in this respect, having neither maxillary nor labial palpi developed.

THE THORAX AND ITS APPENDAGES.

The thorax is the second, or middle division of the bodies of insects. Though apparently single, it is really composed of three pieces soldered

together. These pieces are more distinct in some insects than in others, but they can always be distinguished by impressed lines upon the surface called *sutures*. The three pieces of the thorax are distinguished as the fore-thorax, the middle-thorax, and the hind-thorax; or, in scientific language, the *pro-thorax*, the *meso-thorax*, and the *meta-thorax*. In the Coleoptera the pro-thorax is very large, and forms the large upper part, or shield, to which we usually give the general name of thorax. In this order of insects, the meta-thorax is invisible above, and the only part of the meso-thorax seen from above is the triangular piece between the bases of the elytra, called the *scutellum*.

In many insects (*Hymenoptera* and *Lepidoptera*) the pro-thorax is much reduced in size, and forms only a narrow rim, which is usually called the *collar*.

The under side of the thorax is called the *sternum* or breast plate. Each of the three divisions of the thorax has its sternum, designated respectively as the *pro-*, *meso-* and *meta sternum*. In many insects, and especially the Coleoptera, each section of the sternum is divided by sutures into a middle piece or *sternum* proper, and a side piece, called the *episternum*. These parts will be described more particularly in treating of the Coleoptera.

The *appendages* of the thorax are the organs of motion, namely, the *wings* and the *legs*.

The *Wings*.—The great majority of insects have four wings. The anterior pair are attached to the upper part of the meso-thorax, and the posterior pair to the meta thorax.

The wings are thin, membranous, transparent organs, in some cases folded when at rest, and supported by ribs or veins running across them. These veins are found to correspond in their number and complexity to the rank of the insect in the scale, and from the ease with which they can be seen, they furnish admirable characters for the purposes of classification. In some insects, such as the grass-hoppers, the fore-wings are thicker and less transparent than the hinder pair, and have nearly the consistency of parchment; and in one large order of insects, the Coleoptera or beetles, the fore-wings become converted into the hard opaque pieces, known as the *elytra* or wing-cases. The elytra take no part in flight, but serve only to cover and protect the hinder or true wings, which are folded under them when at rest.

In one large order, the insects have but two wings, and are named from this character *Diptera*, or two-winged insects. In these insects the place of the hind-wings is supplied by a pair of little knobbed appendages called *halteres* or poisers.

There are a few exceptional cases of two-winged insects in some of the other orders—for example, some of the smaller Day-flies (*Ephemeræ*) in the order Neuroptera, and the males of the Bark-lice (*Coccidæ*) in the order Homoptera.

The Legs.—Insects have six legs, attached in pairs to the under side of each of the three segments of the thorax. The leg consists of four principal parts; the hip (*coxa*), a short piece by which the leg is attached to the body; then an elongated piece called the thigh (*femur*, plural *femora*); then another elongated piece called the shank (*tibia*); and lastly the foot (or *tarsus*), which is composed of a number of smaller pieces or joints; of which five is the largest and most common number.

The feet of insects terminate, almost invariably, in a pair of sharp horny claws (*ungues*); and between these, at their base, is often one or two little pads (*plantulæ*) by means of which flies and many other insects adhere to glass, or any other surface which is too smooth and hard for the claws to catch upon. The Lepidoptera have but one plantula, and the Diptera have two. Besides the parts of the leg here enumerated, there is a small piece attached to the hind part of the hip, called the *trochanter*. This is usually small and inconspicuous, but in the hind legs of the ground-beetles (*Carabidæ*) it forms a large egg-shaped appendage, which is one of the most characteristic features of this family of insects.

THE ABDOMEN, AND ITS APPENDAGES.

The abdomen is the hindermost of the three divisions of an insect's body. It is sometimes attached to the thorax by the whole width of its base, in which case it is called *sessile*. But it is often attached by a slender petiole or foot-stalk, when it is said to be *petiolated*. The abdomen is composed of a number of rings, one behind another, each ring usually lapping a little upon the one following it. The normal number of rings or segments of the abdomen is considered to be nine, and this number is actually present in the Earwig (*Forficula*) and a few other insects; but in the great majority of insects, several of the terminal segments are abortive, and only from five to seven can usually be counted.

In the females of many kinds of insects the abdomen terminates in a tubular, tail-like process, through which the eggs are conducted to their place of deposit, and which is therefore called the *ovipositor*. In some insects the ovipositor is simple, short, straight and stiff, as in some of the Capricorn beetles; but in others, as the Ichneumon flies, it is long, slender and flexible, and composed of three thread-like pieces, which when not in use, are separated from each other, giving these insects the appearance of being three-tailed.

Capturing and Preserving Insects.

Insects which do not readily fly, such as the beetles and the bugs proper (*Hemiptera*), can be captured with the fingers, and are easily

killed and also preserved, for the time being, by dropping them into alcohol. For this purpose every collector should have in his pocket one or more small, strong, wide-mouthed bottles, securely corked, and filled about two-thirds full with alcohol. The common morphine bottles answer this purpose very well. The quinine bottle can be used when a larger bottle is required. The insects can be left in the alcohol till the collector has leisure to pin them. They can be taken from the bottle with a pair of forceps, or the alcohol can be turned off into another bottle, and the insects shaken out on to a newspaper, or what is better, a sheet of blotting paper, which readily absorbs the moisture.

Insects which readily take flight, must be captured in a net, which is made like a small dip-net for fishes, by making a hoop of stout wire about ten inches in diameter, with the ends of the wire turned out so as to form a short handle three or four inches long, and this can be lengthened by inserting the ends of the wire into a wooden handle about two feet long. The net is made of lace or tarleton muslin, and should be twenty inches or more in depth.

Many species which would otherwise escape notice, can be obtained by beating the branches of trees, especially forest trees, and catching the insects as they fall. A common umbrella, inverted under the tree, answers this purpose very well. This is in many ways a very useful implement to the collector. It will serve to protect him from the direct rays of the sun, or from a casual shower; and the hook at the end of the handle will enable him to draw down branches so that they can be satsifactorily examined. The umbrella would be improved by being covered with white cloth, upon which small insects would be more easily detected.

Most insects except those above mentioned are injured by being immersed in alcohol, and butterflies and moths would be ruined by it. These insects can be killed by wetting them with benzine or chloroform. The benzine is the cheaper, and the only objection to it is its disagreeable odor. Large insects require to be saturated with chloroform several times to destroy life. A very neat way to kill the smaller moths is to put them under a wine-glass and put in with them a tuft of wool saturated with chloroform. The moths are killed by the fumes, without being wet or handled. Some use for this purpose a poisonous preparation called cyanide of potassium.

In mounting beetles the pin should be passed through the right wing-cover; other insects are pinned through the thorax. The pin should be inserted so far that half of it will project below the body of the insect.

The value of a collection of insects is greatly enhanced by having the legs and wings of the specimens displayed in a life-like attitude. For this purpose they must be set out with pins, and held so a day or two till they have become fixed. For spreading the wings of butterflies and

moths it is indispensable to have a simple apparatus called the *stretcher*. It consists of two strips of nicely dressed soft pine wood, 18 or 20 inches long, two inches wide, and about three-eighths of an inch thick, placed side by side, half an inch apart at one end and quarter of an inch at the other, so as to accommodate insects of different sizes, and held so by a cleet across each end. The space between the strips must be closed on the underside by pieces of sheet cork tacked to the board. The space between the strips is to receive the body of the insect, the pin being passed through the cork so as to bring the wings on a level with the upper side of the stretcher. The wings are spread by catching them just behind the stout front rib with a pin, or, what is better, a needle set into a little handle, and carrying them forward, till the hind margin of the fore-wings are on a straight line with each other. They can be held in this position either by strips of card laid across them and fastened with pins, or by inserting a single small pin through the wing, behind the rib, and into the side pieces of the stretcher, which on this account should be made of the softest kind of wood. For very small moths the stretcher must be constructed upon a smaller scale.

Insects must be allowed to dry thoroughly before inclosing them in the cabinet. Beetles which have been permitted to dry with their limbs contracted, can be relaxed by putting them into hot water.

Boxes for the permanent preservation of insects may be 17 or 18 inches square, two and a half inches deep, outside measurement, and one inch and a half or a trifle more in the clear, made of perfectly seasoned wood, halved together in the middle, so as to have an upper and lower part, the former serving as the cover. The lower part must be lined on the bottom with sheet cork or thin strips of corn-stalk, and the whole covered with soft white paper. The paste with which the paper is attached should have a portion of arsenic stirred in with it, to guard against destructive vermin. The upper part, or cover, should be cut in around the top, like a window sash, so as to receive a plate of glass, which is to be secured in the usual way with putty.

Every insect drawer should have a lump of gum camphor rolled in a piece of muslin and pinned into one corner, to keep out destructive vermin. The presence of vermin is detected by little heaps of the dust-like gnawings under the infested specimens. Such specimens should be at once removed, and if the drawer is much infested, a teaspoonful or two of benzine should be poured upon the bottom, and the drawer or box immediately closed, so as to retain the fumes.

MAGNIFYING GLASSES.

A magnifying glass consisting of one, or, what is better, two lenses, so arranged that they can be used either singly or combined, is absolutely indispensable in studying insects. This simple instrument, the

usual cost of which is one dollar per lens, is all that is usually required. It is a common mistake to suppose that insects cannot be studied and classified without the use of a complex and costly miscroscope. Such instruments are useful only to examine excessively minute or transparent objects, and though sometimes indispensable to the professed entomologist, they are rarely used in the ordinary study of insects.

THE INSTINCT OF INSECTS.

Instinct is that faculty by which animals are enabled to discover their food, construct their nests, and provide for their young, and to perform these operations without having had any previous education or experience. Many of the manifestations of this faculty are truly wonderful and unaccountable. Such are the mathematically accurate construction of the cells of the honey-comb; the curious economy of the ants and bees; and the provisions which many kinds of insects make for the future subsistence of their young, even in advance of their existence.

Instinct is often spoken of as an imperfect or partially developed reason, but its relation to that faculty can be, at most, only that of a very remote analogy. It differs from reason in its invariableness and its almost absolute infallibility, but most essentially in its independency of previous knowledge and experience. Reason acts only by virtue of what is already known, and man, who vastly excels all other animals in his reasoning powers, approaches perfection in any complex work only by long study and practice; the honey-bee, on the contrary, constructs its first cell with such mathematical accuracy that it cannot be improved by any subsequent experience.

Some of the higher animals, such as the horse and the dog, give proof of the possession of a reasoning faculty similar to our own, and inferior only in degree. But whilst the manifestations of reason are fainter as we descend in the animal scale, instinct becomes more remarkable, and in insects especially, in which reason is almost if not absolutely wanting, instinct is exhibited in its highest perfection, far surpassing, in many instances, in accuracy and prescience, the reason of man himself.

Of the nature of the instinct of animals, as of that of the human mind, we know absolutely nothing; and we can only confess our ignorance by referring its wonderful manifestations to the direct agency of the creator.

INSECTS FROM A PRACTICAL OR ECONOMIC POINT OF VIEW.

In regarding insects from this point of view, we have to consider them in both their beneficial and their injurious relations. The directly beneficial insects are almost limited to the three well-known species: the honey-bee, the silk-worm and the cochineal-insect; whereas, those

species which are injurious to mankind, chiefly by depredating upon valuable cultivated crops, are much more numerous, although constituting but a very small proportion of the whole insect world. It is important to bear in mind that in these destructive operations insects occupy an exceptional or abnormal position, and that we ourselves have been the means of bringing about this state of things, by the excessive cultivation of certain plants, whereby a corresponding increase of certain species of the insects which feed upon them has been induced. It is very rarely that any such loss of balance between the insect and the vegetable worlds takes place in the state of nature; and yet, such occurrences are not wholly unknown. This has happened most remarkably in the case of wood-eating insects, there being instances on record in which extensive tracts of forest trees have been destroyed by the larvæ of some of the more minute wood-boring beetles.

But, as just stated, it is in their depredations upon some one or other of the more valuable cultivated crops that insects have come into the most direct and serious conflict with human interest. These depredations, as is well known, have often been of a most extensive and ruinous character, causing the annual loss of crops to the value of many millions of dollars, and in some seasons and localities, necessitating the total abandonment of some of the most valuable and staple productions, such as wheat, barley and potatoes, and also some of our choicest fruits, such as the plum and the peach; and sometimes threatening the destruction even of the most valuable fruit of all—the hardy and widely distributed apple. These destructive operations of insects have necessarily attracted to them the most earnest attention of both practical and scientific men, and many valuable treatises and reports have been written which have been devoted chiefly to the practical treatment of the subject. It is our present intention to treat of insects from a more general and comprehensive point of view.

GENERAL UTILITY OF INSECTS.

From what has just been said, it is evident that it is in the nature of their food and their food-taking habits, that insects hold the closest relationship to human interests; and this is true not only in the direct manner above described, but also indirectly, by means of the important parts which they fulfill in the economy of nature. Indeed, the operations of insects in this last respect are of such vast importance, that it would be safe to say that if these should cease, the earth would soon become uninhabitable by mankind. These operations consist chiefly, first, in the destruction of other insects by the predaceous and parasitic kinds, whereby the excessive increase of the former is held in check; secondly,

in the instrumentality of a large proportion of insects in their character of scavengers, whereby the decomposition of decayed and offensive matters, both animal and vegetable, is effected and accelerated; and thirdly, in the agency of insects in causing the fertilization of plants, especially those with very deep corollas, and those which have the barren and the productive flowers upon different plants, by carrying upon their legs, in their search for honey, the fertilizing pollen from one flower to another. A long chapter might be written upon each of these topics, but we have space here barely to enumerate them.

DIVISION OF INSECTS ACCORDING TO THE NATURE OF THEIR FOOD.

From this point of view all insects may be divided into two classes—the carnivorous insects, or those which eat animal food, (*Sarcophaga*); and the herbivorous insects, or those which subsist upon vegetable substances, (*Phytophaga*). Each of these classes is again divisible accordingly as the insects which compose it take their food in a fresh and living state, or in a state of decay. The former are called predaceous insects (*Adephaga*), when they live upon animal prey; and the latter are designated by the name of scavengers (*Rypophaga*). Those insects which eat living animal food, are still further divisible into predaceous insects proper, which seize and devour their prey, and parasite insects, which live within the bodies of their victims and feed upon their substance.

Those insects which feed upon decaying animal matter present three divisions: first, general scavengers, which devour particles of putresent matter wherever they may be found; second, those which live exclusively in or upon the bodies of dead animals, (*Necrophaga*); and thirdly, those which are found exclusively in animal excrement, (*Coprophaga*).

The herbivorous insects may be divided in a similar manner into those which eat fresh vegetable food, (*Thalerophaga*), and those which subsist upon vegetable matters in a state of decay, (*Saprophaga*). They can also be usefully classified according to the particular parts of the plant which they devour, into lignivorous or wood-eating insects, (*Xylophaga*); the folivorous, or leaf-eating insects, (*Phyllophaga*); and the fructivorous, or fruit-eating insects, (*Carpophaga*).

The above Greek terms in parentheses have been used chiefly in connection with the insects of the coleopterous order, in which these diversities of food-habits exist to a much greater extent than in any of the other orders, but the terms themselves are of general signification, and being very concise and comprehensive, they might, not improperly, be used in speaking of insects in all the orders, so far as they are applicable.

DIFFERENCE OF FOOD OF THE LARVA AND THE PERFECT INSECT.

In attempting to classify insects according to the nature of their food we meet with a peculiar difficulty, owing to the remarkable change which some species undergo in this respect, in passing from the larva to the perfect state. Most caterpillars, for example, feed upon leaves, whilst the butterflies and moths which they produce subsist upon the honey of flowers, or other liquid substances. Some two-winged flies (*Asilidæ*) feed upon the roots of plants in their larva state, but become eminently predaceous in their winged state. Another remarkable example is furnished by certain coleopterous insects (*Meloidæ*,) which are parasitic in their larva state, but subsist upon foliage after they have assumed the beetle form. The question therefore arises, to which stage of the insect's existence shall the precedence be given in this respect? At first view it would seem that the perfect state ought to govern, but when we take into account that insects are comparatively short lived in this state; that having arrived at maturity they require but little food; and that some insects take no food at all at this stage of their lives; whereas all the growth of an insect takes place whilst it is in the larva state, and consequently it is in this state that they feed so voraciously: when we consider this, it seems more reasonable that in classifying insects upon this basis, the food-habits of the larva should take the precedence.

In the following work I have not thought it best to adopt any inflexible rule in this matter, but have been governed by one or the other view accordingly as its importance might seem to preponderate in each particular case.

DISTINCTION BETWEEN NOXIOUS AND INJURIOUS INSECTS.

The terms noxious and injurious are often used indiscriminately, but strictly speaking, noxious insects are those which are endowed with some poisonous or otherwise hurtful quality; and these are divisible into two classes accordingly as they are hurtful to mankind directly, such as the mosquito, flea, and bed-bug; or are hurtful to the domesticated animals, as the horse-fly, the bot-fly, and the various kinds of animal lice. The insects which attack man directly are annoying rather than seriously hurtful, and this is usually the case also with those which molest the domesticated animals; but these sometimes multiply so as to seriously impoverish the animals which they infest.

The term *injurious*, as distinguished from *noxious*, is properly applied to all those insects which damage mankind indirectly, but often to a most serious extent by depredating upon those crops upon which we depend for subsistence and profit.

NUMBER MORE IMPORTANT THAN SIZE.

It is worthy of remark that by far the greater proportion of the damage caused by injurious insects is effected by species of very small size, whilst the large species are generally harmless. The two most serious fruit insects, the Codling-moth and the Plum-curculio, are both below the medium size, and the Apple bark-louse, the Apple-aphis, the Hessian-fly, and the Wheat-midge, are so minute that they would not be noticeable were it not for the wide destruction which they cause to some of our most valuable crops, in consequence of their excessive multiplication.

TREATMENT OF INJURIOUS INSECTS.

For the details of treatment the reader is referred to the practical treatises and reports which have been published upon this subject. We can give here only an abstract of the methods to be pursued.

First, hand-picking and destruction by machinery, as in the case of the Colorado potato-beetle; second, poisoning by such substances as Paris-green, hellebore, and carbolic-acid, as in the cases of the Potato-beetle, and the Currant saw-fly; third, rendering their food distasteful and repugnant to them by the application of such substances as ashes, lime, and whale-oil soap, which are applicable to all foliage-eating insects; fourth, anticipating their attacks by planting at such times as will cause the crops to sprout or to mature too early or too late for them, both of which plans are exemplified by winter wheat, in its relation to the Chinch-bug and the Hessian-fly; and fifth, when all other means fail, preventing their ravages by abstaining for a year or two from raising the damaged crops. To these may be added, in certain favorable instances, the transportation and colonization of friendly parasites. An experiment of this kind has been performed by the author by the transportation from the central to the northern parts of the State of Illinois, of the minute Chalcis-fly which is parasitic upon the Oyster-shell Bark-louse.

The above list exhibits the most common methods of contending with injurious insects, and these methods admit of almost indefinite modification. But they can be most usefully described in connection with the particular species of insect to which they are respectively applicable.

USE OF LEARNED AND SCIENTIFIC TERMS.

With regard to the use of scientific terms, derived mostly from the Greek and Latin languages, it is to be remarked that though they may appear difficult and forbidding, at first sight, the student soon becomes familiarized with them and finds them to be almost indispensable by enabling him often to express in one or two words what would require a

whole sentence in English. It is also an important consideration that in learning the elements of any science or art, an indispensable part of such education is to acquire a knowledge of the more common technical terms which properly belong to it, and which constitute its peculiar phraseology, and which the student will continually meet with in all writings upon the subject. In a work intended, like the present, for the common student, all unnecessary use of such words should, of course, be avoided, and whenever we have found it necessary to use them, we have taken care, as a general rule, to explain their meaning, either directly or by the nature of the context.

The student must not expect that any science can be so simplified as to remove all difficulties; and especially true is this of so extensive and complex a science as entomology. Nor is it desirable that this should be done. One of the principal advantages to be expected from the study of this science is the admirable mental discipline which it affords. The forms with which it has to deal are so numerous and diversified, and often, at the same time, so closely allied, that their classification constantly demands a minute and careful examination, and a discriminative analysis, which, regarded purely as an exercise of the mind, are scarcely inferior to those required by the abstract mathematics, whilst they possess the additional interest which naturally attaches to the study of living beings.

CLASSIFICATION AND NOMENCLATURE.

Classification in natural history, has two objects in view—first, to show the relationship which exists between organized beings, by putting them in groups in accordance with the similarity of their characters; and secondly, to facilitate the study of them by enabling the student to comprehend a great number of different but allied forms under a comparatively small number of general heads, and thus to afford an important aid to the memory.

By nomenclature is meant the giving to these groups and the species which compose them distinctive names. This is necessary to enable us either to receive or to communicate knowledge; and without it natural history could not be raised to the dignity of a science.

In a department so extensive as that of insects, a very great number of names, not only of species, but of the groups in which these are comprehended, must be necessarily introduced. It is therefore important that the science shall not be encumbered by the creation of unnecessary genera, or such as are founded upon slight and unimportant characters. It is, indeed, often difficult to determine precisely what characters or combination of characters necessitate or justify the formation of a new genus, or the subdivision of an old one. No definition of the term *genus* which is universally applicable, ever has been, or perhaps

ever can be given, inasmuch as the characters which constitute it often possess very different values in the different genera and families, not only of insects, but of animals generally, and therefore the formation of genera must necessarily be left to the judgment of the author.

It is the natural tendency of the specialist to attach undue value to the minor subdivisions of his particular department, whilst he whose studies take a wider range sees more forcibly the necessity of condensation and simplification. Much can be said upon both sides of this question, but perhaps the argument may be condensed into a single sentence by saying that, on the one hand, the minute subdivision of a natural group tends to give definiteness and precision to our investigations, whilst, on the other hand, the multiplication of genera or subgenera upon trivial characters, unnecessarily encumbers our nomenclature, and diminishes the interest and importance which ought to attach to the generic distinction.

In writing the names of insects—and the same rule applies to all other departments of natural history—it is the established custom to write first the name of the genus, usually without the author's name attached, and immediately following it the specific name, with the name of the original describer, or an abreviation of it, appended. As no one can carry all the modern genera of insects in his memory, it is an excellent practice, when space permits, to prefix the name of the older and more comprehensive genus to which such species was formerly referred, and with which most entomologists may be presumed to be familiar. In this case the modern genus is included in a parenthesis, and usually with the author's name attached.

To illustrate by examples: The common rose-slug is the larva of a little wasp-like insect known scientifically as the *Selandria rosæ* of Harris. This species was first described by Dr. Harris, who gave to it the specific name *rosæ*, meaning *of the rose.* It belongs to the modern genus *Selandria*, which was founded by Dr. Leach, an English entomologist. This genus is a subdivision of the old genus *Tenthredo*, of Linnæus. The name written in full, therefore, will stand:

Tenthredo (Selandria, Leach*) rosæ*, Harris.

Our fine large Polyphemus moth was originally described by Linnæus under the name of *Attacus Polyphemus.* It belongs to the modern genus Telea, made by the German lepidopterist, Hubner. Its name, therefore, expressed in the simplest manner, is *Telea Polyphemus*, Linn.; or written in full—

Attacus (Telea, Hubner*) Polyphemus*, Linnæus.

This is ordinarily all that is essential to be known, and any additional synonyms or references should be placed in a subordinate position.

It will be observed that all the family names of insects end in *idæ.* This is a Greek termination, meaning *like* or *similar*, and implies that all the species in any such group have a family resemblance to those of the leading genus to which it is affixed—thus: *Cicindelidæ* means *Cicindela—like* insects. In pronouncing these words the accent is placed upon the syllable preceding this termination, thus: *Cicindel-idæ, Carab-idæ,* etc.

It is often the case that families, especially those which contain many species, admit of division into a number of natural groups of a higher rank than genera, which are designated as sub-families, and distinguished by the termination *ides.* Thus the family Carabidæ is divided into a number of sub-families, such as the *Brachinides*, the *Scaritides*, etc.

DIVISION OF INSECTS INTO ORDERS.

The class of insects is divided into a number of primary groups called *orders.* Between these larger divisions are certain smaller ones, which serve as connecting links between them, and which some authors have merged in one or the other of the adjoining larger groups, whilst others have considered them of sufficient importance to be raised to the same rank with the larger ones. From this it has resulted that the number of orders into which the class of insects has been divided has varied, even in the works of standard authors, from seven to twelve; and the number will be still increased if we regard as distinct orders certain apterous forms such as the lice (*Pediculi,*) and the springtails (*Thysanura.*)

But as in this elementary treatise it is the intention to simplify the classification of insects as much as possible, we have adopted the smaller number of orders, with the single exception of recognizing the division of the Hemiptera into Homoptera and Heteroptera as of ordinal value.

The orders of insects are founded primarily upon the number and structure of the wings. This mode of division was first suggested by Aristotle, who gave the names which they now bear to two of the orders, namely, the Coleoptera and the Diptera. It was afterwards almost perfected by Linnaeus, but has been somewhat modified by more recent authors.

The orders, at the present time, are usually arranged in two sections, with four orders in each, based upon the form and structure of the mouth.

Section 1st. *Mandibulata*, or *Gnawing insects.*—Mouth composed of jaws and mandibles.

A. Upper wings of a horny or leathery consistency; under wings membranous.

B. Upper wings horny, and usually inflexible; under wings folded both lengthwise and crosswise; inactive in the pupa state: COLEOPTERA.

B B. Upper wings coriaceous, or like parchment; under wings folded lengthwise only; active in all their stages: ORTHOPTERA.

A A. All four wings membranous and transparent.

C. Wings with many branching veins, and usually many cross-veins; abdomen without an ovipositor....NEUROPTERA.

C C. Wings with comparatively few veins; abdomen of the females terminating in an ovipositor or sting: HYMENOPTERA.

Section 2d. *Haustellata*, or *Sucking insects.*—The mouth consolidated into a proboscis or sucker.

A. Wings four.

B. Wings covered with bran-like scales..........LEPIDOPTERA.

B B. Wings naked.

C. Upper wings of the same texture throughout, not lapping over each other, deflexed or roof-shaped when at rest: HOMOPTERA.

C C. Upper wings coriaceous at base, membranous at tip, lapping one over the other at the tip, and lying flat upon the abdomen when at rest............HETEROPTERA.

A A. Wings two, membranous.......................DIPTERA.

ORDER OF COLEOPTERA.

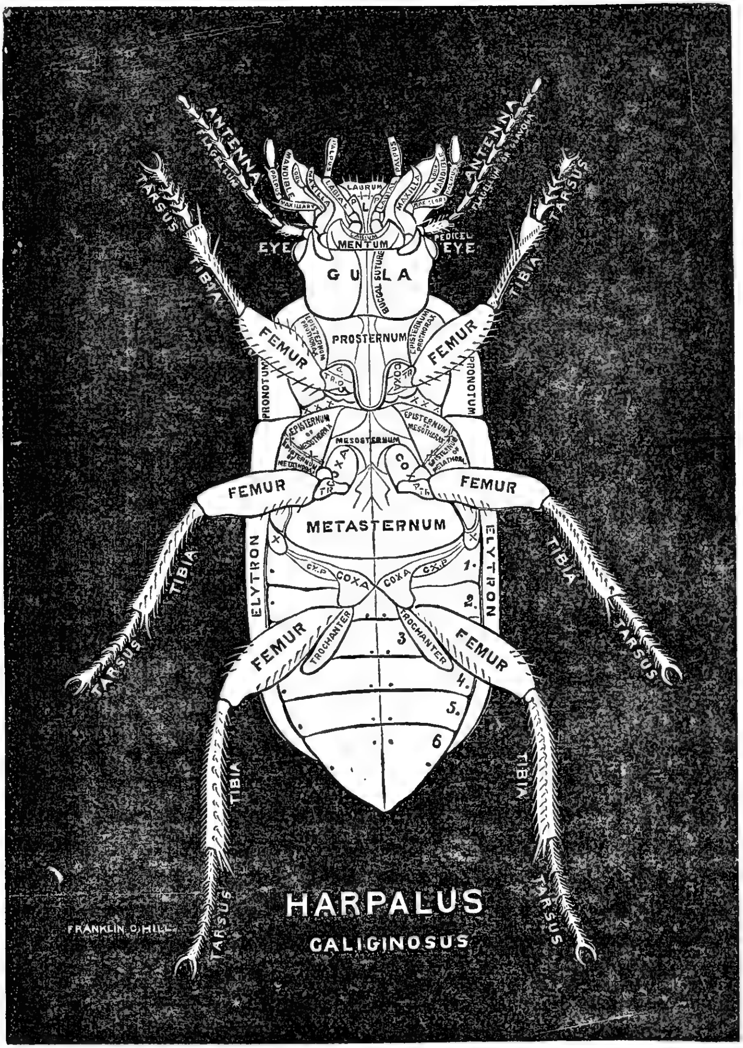
The Coleoptera, (a term composed of two Greek words, *χολεος a sheath*, and *πτερα wings*,) commonly called *beetles*, are the most numerous division of the mandibulate or gnawing insects. They are distinguished from all other insects by the hard texture of their bodies, and by their horny wing-covers, called *elytra*, which represent the upper pair of wings of other insects. The elytra are not moved in flight, but only raised so as to permit the free motion of the lower or true wings, and a few of the chafers (*Cetoniæ*) do not even raise them during flight. They are generally hard, horny and inflexible, but in the lightning-beetles (*Lampyridæ*) and a few others, they are comparatively thin and flexible, but never membranous like the lower wings. The inferior or true wings differ from those of almost all other insects in being folded crosswise, as well as lengthwise, when at rest under their cases. The Buprestidæ and a few others form exceptions to this rule. A few kinds which live under stones and in other dark places, and which have no occasion to fly, have no wings under their elytra.

Owing to the perfect development and the hard texture of the crust or integument of the Coleoptera, and also to the circumstance that it is not usually much obscured by hair, this part is made more use of in classification than it is in any of the other orders. The upper side exhibits the three divisions of the insect's body: the head; the thorax; and the abdomen, covered by the elytra. Between the elytra, at their base, or where they join the thorax, is almost always a small triangular piece called the *scutellum*. On the under side, each of the principal parts is seen to be composed of a considerable number of pieces usually soldered together and distinguished only by fine impressed lines, called *sutures*. These subdivisions and their names will be sufficiently understood, without the necessity of a detailed description, by the annexed figure of one of the ground-beetles (*Harpalus caliginosus*) and the accompanying explanation, taken in connection with the general description in the beginning of this work.

EXPLANATION OF THE FOLLOWING FIGURE.

The oblong narrow piece in the middle of the mouth, marked L, is the *ligula* or tongue. At the extremity of the ligula are two little wings or side pieces marked *p p;* these are the *paraglossæ*. The other parts of the mouth are named in the figure, and have been described in the introductory part of this work. The under side of the head, behind the mentum or chin, is called the *gula* or *throat*.

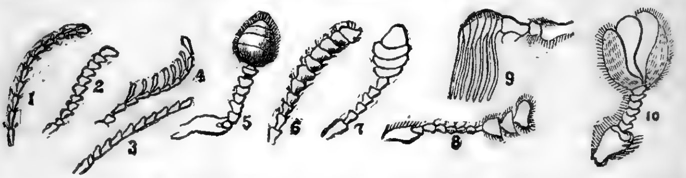
The under side of the thorax is divided into a considerable number of pieces more or less distinct, and separated from each other by impressed lines called *sutures*. The middle portion is called the *sternum*



or breast-plate, and is divided into three parts, the *prosternum* or fore breast-plate; the *mesosternum* or middle breast-plate; and the *metasternum* or hind breast-plate. Each of these parts has a side piece called the *episternum;* so that there is an episternum of the prothorax; an episternum of the mesothorax; and an episternum of the metathorax; all of which are labelled in the figure. Directly behind each episternum is a smaller piece called the *epimeron.* These are indicated in the figure by stars; three stars marking the epimeron of the prothorax; two stars the epimeron of the mesothorax; and one star the epimeron of the metathorax. The epimeron of the mesothorax is very narrow in Harpalus, and scarcely distinguishable without the aid of a lens; but

in a part of the long-horned beetles (*Saperdæ*, etc.) and in some others, it is considerably wider, and affords valuable characters in classification. The *trochanters*, or little joints at the base of the thighs, are marked TR in the figure, except the large hind trochanters, where the name is printed in full. Behind the metasternum, and extending outwardly from the hind coxæ is a narrow piece marked CX. P. This is the *hind coxal plate.* This is a very narrow piece in Harpalus, but in some of the serricorn beetles (*Buprestidæ* and *Elateridæ*), it is much wider, and furnishes important generic characters; and in Haliplus, a genus of water beetles, it is excessively dilated. The other parts are sufficiently named in the figure.

The antennæ of the Coleoptera are usually eleven jointed and of moderate length, but they are subject to much variation both in length and form, as will appear in the descriptions of the different families. The subjoined figures show their most common variations, and the names by which they are designated. These forms have been more particularly described on a former page, when treating of insects in general.



Explanation.—1, filiform or thread-shaped; 2 and 3, serrate or saw-toothed; 4, pectinate or comb-toothed; 5, capitate or knobbed; 6, 7, 8, clavate or club-shaped; 9 and 10, lamellate or plated.

The palpi, or little jointed appendages to the mouth, also sometimes furnish important characters in classification. They vary chiefly in the shape of the terminal joint, which is sometimes much narrower than the others, when it is called *acicular* or needle-shaped, and sometimes much widened, so as to be in the form of a triangle or of a half moon, or hatchet.

As the terms *large*, *small*, and *medium-sized* are often used in speaking of insects, and as these words vary considerably in force, when used in different relations, we give below their average meaning when applied to the Coleoptera:

An inch or more in length, - - - - -	Very large.
Three-quarters of an inch, - - - - - - -	Large.
Half an inch, - - - - - - - - - -	Medium.
Quarter of an inch, - - - - - - -	Small.
One-eighth of an inch or less, - - - - -	Very small.

The intermediate sizes are expressed by such phrases as, *rather large*, *rather small*, or *a little above*, or *a little below the medium*, etc. This standard applies only when speaking of any one group of beetles as compared with the Coleoptera generally. The same expressions will

necessarily vary in force when applied to the species of a particular group as compared with each other, accordingly as the species of that group are large or small as compared with the rest of the order; that is to say, a small species of a group of generally large-sided insects, may be larger than a large species of a small-sized group.

LARVÆ AND PUPÆ.

The *larvæ* of the Coleoptera are usually soft whitish grubs; naked, or with a few scattered hairs; with a mandibulate mouth not very unlike that of the perfect insects; usually furnished with six short feet and a single terminal proleg, but sometimes wholly footless. They live in secluded situations, sometimes in the ground, but oftener in the wood or under the bark of decaying trees, or in putrescent animal substances, and not unfrequently in nuts and seeds, and in the pulp of fruits. They are rarely found exposed to the light of day, and therefore they never exhibit the beauty of coloration, nor the variety of clothing which gives so much interest to the study of the caterpillars, properly so called, which are the larvæ of the moths and butterflies. The larvæ of most of the families of Coleoptera are now pretty well known, but owing to the circumstances just mentioned, they have generally received but little attention from entomologists compared with that which has been bestowed upon the perfect insects. The larvæ of the several families will be more particularly described in their proper connections.

The *pupæ* are never inclosed in cocoons, but the larvæ, before changing, simply form cells by turning themselves round and round in the earth or rotten wood, in which they usually undergo their metamorphoses. The legs are free, that is not concealed from view under a pupa case, but they are not used, the insects being dormant and motionless during this stage of their existence.

THE COLEOPTERA FROM A PRACTICAL POINT OF VIEW.

In order to show more clearly the connection between scientific and practical entomology, in classifying the Coleoptera we have taken the food-habits of the several species as the basis of classification, it being in the nature of their food, and their methods of obtaining it, that insects come into the most important relationship to mankind, whether of an injurious or a beneficial character. We refer to the Coleoptera particularly, because they exhibit a much greater diversity of food-habits than any of the other orders of insects. Indeed this principle of classification is of value just in proportion as such diversity exists; and where it is very limited, as especially in the great order of Lepidoptera, it ceases to be available. Even in classifying the Coleoptera upon this basis, and at the same time paying the necessary respect to structural

considerations, we are sometimes compelled to place insects of similar food-habits in several different, and sometimes remote, tribes. The wood-boring beetles, for example, constitute three distinct tribes, designated as the saw-horned borers (*Buprestidæ*); the long-horned borers (*Cerambycidæ*); and the short-horned borers (*Scolytidæ*). There are likewise four distinct families of fungus-beetles, found respectively in each of the four tarsal sections. But notwithstanding such instances as these, the Coleoptera admit of a very interesting, useful, and, in the main, natural classification in accordance with the nature of their food.

As compared with the other orders of insects the Coleoptera are surpassed only by the Lepidoptera in the extent of their injuries to cultivated crops; and indeed they are so nearly equal to the latter in this respect, that there may be a doubt which takes the precedence ; and it is true of either of these two orders, that, with the exception of the other, it includes a greater number of injurious species than all the other orders of insects combined. The great destructiveness of the Lepidoptera is readily explained by the nature of their food, nearly all their larvæ, commonly known as caterpillars, subsisting upon plant-food, and mostly in a fresh and growing state. The Coleoptera, on the contrary, embraces, in addition to the plant-eating species, extensive tribes of predaceous and scavenger beetles, which are indirectly of incalculable benefit to mankind.

In studying the bearing of scientific upon practical entomology, nothing perhaps is more important than to trace the connection of the external structure of insects with their habits, and especially with the nature of their food; since we are thus enabled, to a certain extent, to determine the habits of an insect by simply observing the form and structure of its visible parts. We are able to lay down some general rules of this kind with respect to the Coleoptera, though most of them are subject to important exceptions. In order not to give too much space to this part of the subject, we will limit our observations to two of the most important and prominent organs, the antennæ, and the feet, or tarsi.

All predaceous beetles have filiform antennæ except the lady-bugs or Coccinellidæ.

All the scavenger beetles have strongly clavate or knobbed antennæ, except the short-winged scavengers or Staphylinidæ.

All the leaf-eating beetles have filiform or nearly filiform antennæ, except the herbivorous Lamellicorns (*Rutelidæ* and *Melolonthidæ.*)

All fungus-eating beetles have the antennæ more or less strongly clavate.

The feet of the Coleoptera are of two principal kinds; first, *simple feet*, in which the joints are slender, and of about the same width

throughout, and clothed only with somewhat scattered bristles; and secondly *bi-lobed feet*, in which the joints are somewhat widened and depressed, with the last joint but one wider than the others, and divided into two lobes, between which the last joint is inserted, and all of them clothed beneath with densely crowded short stiff hairs, of the same length, so as to resemble a brush; sometimes also compared to a piece of sponge.

As a general rule, beetles with simple feet reside upon the ground, or under the bark of dead trees, or in other decomposing matter, and are either carnivorous or rypophagous (filth eating) in their habits; and those which have bilobed and spongy feet live upon the foliage of trees and other plants, this structure of the feet seeming to be especially adapted to enabling them to adhere to the surface of leaves; and accordingly most of these insects are herbivorous.

But this general statement is subject to important exceptions. Some of the lamellicorn beetles *(Melonthidæ, Rutelidæ,* etc.*)* have simple feet and yet feed upon the foliage of trees; but these insects do not run over the leaves, but simply cling to them with their sharp claws, whilst feeding.

So, also, some carnivorous beetles *(Telephoridæ* and *Coccinellidæ)*, which pursue their prey over the foliage of trees, have their feet bilobed and spongy.

It is an interesting circumstance that those insects *(Melolonthidæ,* etc.*)* which only cling to the foliage by their claws, do not breed upon the trees, but pass their larval period under ground, subsisting upon roots or other subterranean matters, and only visit the trees for the sake of feeding; whereas the true Phytophaga, with spongy feet (*Chrysomelidæ* and their allies) live upon the plants upon which they feed, through all the stages of their existence.

It is also a curious coincidence that the insects first mentioned, which only visit the trees occasionally for the purpose of feeding, do so only by night; whilst the genuine Phytophaga (plant eaters) are diurnal in their habits.

There is another partial but important exception to the rule above laid down, as respects the males of many carnivorous beetles, which have some of the joints of their anterior feet much widened and brushed underneath; but here the last joint but one is not bilobed, and the brush is usually confined to the anterior pair of feet, rarely extending to the middle pair, and never to the hind ones; besides being limited exclusively to the males.

Whilst some of the other orders of insects excel the Coleoptera in the perfection of their instincts, no other order can be compared with them in the diversity of their food, and their corresponding habits and organization. Indeed the Coleoptera combine, to a great extent, the food.

habits of all the other orders. The herbivorous habits of the Orthoptera, the carnivorous habits of the Hemiptera, the aquatic habits of the Neuroptera, the honey-eating and the parasitic habits of the Hymenoptera, the leaf-eating habits of the larvæ of the Lepidoptera, and the putrivorous habits of the Diptera—all find their parallel in the ranks of the omnivorous Coleoptera.

SUGGESTIONS TO AID IN CLASSIFYING THE COLEOPTERA.

The student will perceive that the primary division of Coleopterous insects is based upon the number of joints in their feet, or tarsi. This character, though apparently of trivial importance, is found to furnish an index to a more natural classification than can be established upon any other single character. In almost all beetles of considerable size, that is, more than quarter of an inch in length, this character is very uniform, or, in other words, the number of tarsal joints in the insects of any one section or family, is remarkably unexceptional. It also has the advantage, in insects of this size, of being easily determined, if not by the naked eye, at least by the aid of a simple lens.

But the insects which are necessarily the most difficult to examine and classify are the very small ones, and here the character founded upon the number of tarsal joints not only becomes more difficult to determine, but more exceptional, and therefore of less value. We therefore give the following suggestions to aid the inexperienced student in cases of this kind.

It will be seen that the whole order of beetles may be divided into four sections:—First, the *pentamera*, or those having five joints in all their tarsi; second, the *heteromera*, or those having five joints in the anterior and middle tarsi, and four joints in the hindermost; third, the *tetramera*, or those having four joints in all the tarsi; and fourth, the *trimera*, or those having three joints in all the tarsi.

The last section contains strictly but two families, the Coccinellidæ and the Endomychidæ, though another family, the Erotylidæ, having four joints in their tarsi, are usually classed with them. The species in this section are so comparatively few in number and usually so well marked by their other characters that the student will seldom have any difficulty in distinguishing them.

The second and third sections are very nearly unexceptional in the number of the tarsal joints. The principal difficulty occurs, therefore, with respect to numerous families containing very small species in the first or pentamerous section; and these are mostly limited to what are known as scavenger beetles, both the club-horned tribe, (*Clavicornes;*) and the short-winged tribe, (*Brachelytra.*) In the minute species of both of these tribes the number of tarsal joints is very irregular, one of them

being often indistinct or wanting, especially in the posterior feet, and in three families at least the Lathridiidæ, Trichopterygidæ and Pselaphidæ, two joints are wanting in all the feet, making them apparently but three-jointed.

The student will naturally inquire, why place these insects in the pentamerous section? The answer is, that they harmonize more closely with the insects of this section in their other characters, whilst they do not affiliate with the insects of the other sections which agree with them in the number of tarsal joints. An examination of their other characters will usually enable the student, after a little experience, to refer these insects to their true position; though cases sometimes occur which puzzle the most astute entomologist. They can hardly be confounded with the Heteromera, because these are, for the most part, much larger insects, and the exceptionally small species belong mostly to the tribe of Trachelides, which are distinguished from these and most other beetles by having the head attached to the thorax by a narrow neck. They differ from the Tetramera in the form of the tarsi and also that of the antennæ. Almost all these small species with deficient tarsal joints, have these parts slender and simple, whilst all the genuine Tetramera have the tarsal joints somewhat widened and covered beneath with a dense brush of short hair, and the last joint but one is wider than the others, and divided into two lobes, between which the last joint is inserted. The only pentamerous beetles which have some of their tarsal joints obsolete, and at the same time have the last joint but one bilobed, are a part of the serricorn family of Cleridæ. Some of the short-winged scavengers with an irregular number of tarsal joints (Staphylinidæ), have a part of these joints widened but not bilobed in the males, but here it is a sexual distinction, and is confined to the anterior feet.

These small Pentamera, with variable tarsi, almost always have strongly clavate antennæ, except the Staphylinidæ, and these are distinguished at once by their short wing-covers. The true Tetramera, on the contrary, have the antennæ filiform, or at most slightly and gradually enlarged toward the tip, except the snout-beetles (*Curculionidæ*), and these are readily known by their elongated rostrum.

If, then, the student have in hand a small beetle whose place in the system he cannot determine with certainty, from the number of tarsal joints, let him first observe whether these joints are simple and of the same width throughout, or whether the last joint but one is a little wider than the others, and deeply notched or bilobed at the end; and next, let him examine the antennæ, and observe whether they are slender and filiform, or whether they are decidedly enlarged at the end, either gradually (clavate), or suddenly (capitate).

1. *If the tarsi are simple and the antennæ filiform,* the species may belong to some one of a number of diverse families (Carabidæ, Elateridæ, Mordellidæ, Melandryidæ, Cistelidæ, and a few smaller families); but the beetles with this combination of characters are rarely of very small size, and they are, therefore, the more easily determined by their other characters.

2. *If the tarsi are simple and the antennæ clavate or capitate,* the insect may be referred, with very few exceptions, to some one of the families of scavenger beetles in the pentamerous section. This rule embraces a large proportion of very small-sized beetles, and will, therefore, be found of great use to the student in narrowing the field of his inquiry. A few apparent exceptions exist in the heteromerous families of Diaperidæ and Tenebrionidæ, but the former can be usually distinguished by their perfoliate antennæ, and the antennæ of the Tenebrionidæ are usually so slightly enlarged towards the tip as scarcely to be entitled to the name of clavate. Other partial exceptions are found in the family of Scolytidæ, or short horned wood-borers, all of which have strongly clavate antennæ, and some of which have simple tarsi; but many of them have the last joint but one slightly bilobed.

3. *If the last joint but one of the tarsi is bilobed and the antennæ filiform,* the insect belongs to the family of long-horned borers (*Cerambycidæ*), or to that of the plant-beetles proper (*Chrysomelidæ*, etc.) The tarsi thus formed are almost always spongy on the under side. Only a few partial exceptions to this rule are found, and these are in the heteromerous families of Œdemeridæ, Anthicidæ, and a few others; but in these the tarsi are usually but slightly dilated, and but little, or not at all, spongy beneath.

4. *If the tarsi are bilobed and the antennæ clavate,* the species belongs to the tribe of snout-beetles (*Curculionidæ*), in the terramerous section, or to the family of Erotylidæ, or that of Coccinellidæ, in the trimerous section.

5. *Beetles with distinctly serrate antennæ* belong almost exclusively to the families of Serricornes proper, in the pentamerous section; but this rule also has a few exceptions. The pea and bean weevils (*Bruchidæ*), in the tetramerous section, usually have the antennæ decidedly serrate; and a few small families of the division of Trachelides, in the heteromerous section, (*Rhipiphoridæ* and *Pyrochroidæ*,) usually have the antennæ serrate in the females, and flabellate or branched in the males.

6. *All beetles with lamellate antennæ* belong to the division of Lamellicornes proper, in the pentamerous section. Only in very rare instances the branches of a pectinate or flabellate antenna are somewhat flattened so as to resemble the true lamellate. An example of this is found in the little beetles of the genus Phlœotribus in the family of Scolytidæ.

CLASSIFICATION OF THE COLEOPTERA.

The Coleoptera are divided into four sections founded upon the number of joints in their tarsi, or feet. We have explained sufficiently the value of this character in the foregoing preliminary remarks.

These sections may be tabulated as follows:

Sec. 1.	Five joints in all the tarsi	*Pentamera.*
Sec. 2.	Five joints in the anterior and middle tarsi, and four joints in the hind tarsi	*Heteromera.*
Sec. 3.	Four joints in all the tarsi	*Tetramera.*
Sec. 4.	Three joints in all the tarsi	*Trimera.*

These terms, except the second, are composed of the Greek numerals meaning respectively, *five*, *four*, and *three*, prefixed to a word meaning *parts* or *pieces*. The prefix *hetero*, in the second section, means *different*.

As a general rule insects have five joints in their tarsi, and never more than five. This may, therefore, be regarded as the normal or typical number, and a smaller number must be taken as an indication of inferiority or degradation, using this word in its scientific sense. In accordance with this view, the most perfect and highly organized beetles are found in the pentamerous section; and in those which have less than five joints, there is usually a little swelling at the base of the last joint, which is supposed to be a vestige of the missing joint. This circumstance has led some authors to give more complex names to these sections, expressive of this character, but with the explanation here given we have preferred to retain the simpler nomenclature of Olivier and Latreille.

SECTION 1. *PENTAMERA.*

Five joints in all the tarsi.

This is the most numerous section, and comprises, as a general rule, the largest and most highly organized species in this order of insects, though it also contains many small species.

They can be divided into six sub-sections, founded upon their habits and the nature of their food, and distinguished primarily by the structure of their antennæ; and these sub-sections are again naturally divisible into a number of subordinate divisions or tribes. The following table gives a synopsis of the sub-sections, tribes, and families of the pentamerous beetles. The names given to these sub-sections are generally recognized, and in common use, except the first and the third. The term *filicornes*, though sufficiently characteristic of the predaceous beetles as compared with others of the pentamerous section, does not sharply distinguish them from some of the beetles of the other sections; and the term *monilicornes*, applied to the third sub-section—which is composed chiefly of the family of Staphylinidæ, though tolerably characteristic, especially of the larger and typical species—is not ordinarily

applied to them, for the reason that the beetles of this division are more readily and strongly distinguished by another character, namely, the remarkable shortness of their wing-covers, expressed by the Greek term *brachelytra*, by which they are generally designated, or the corresponding Latin word *brevipennes*, which is sometimes, but less commonly used.

SYNOPSIS OF THE PENTAMEROUS COLEOPTERA.

SUB-SEC. I. *Filicornes.* Antennæ filiform. Habits predaceous.

Tribe 1. Predaceous ground beetles. (*Carnivora terrestria.*) GEODEPHAGA, MacLeay.

Families: Cicindelidæ; Carabidæ.

Tribe 2. Predaceous water beetles. (*Carnivora aquatica.*) HYDRADEPHAGA, MacLeay.

Families: Dytiscidæ; Gyrinidæ.

SUB-SEC. II. *Clavicornes.* Antennæ club-shaped. Habits mostly putrivorous.

Tribe 3. Water scavengers. (*Putrivora aquatica.*) PHILHYDRIDA, MacLeay.

Families: Parnidæ; Hydrophilidæ.

Tribe 4. Land scavengers. (*Putrivora terrestria.*) NECRO PHAGA partly, Latreille.

Families: Silphidæ; Scaphidiidæ; Histeridæ; Nitildulidæ; Dermestidæ; Mycetophagidæ; Cryptophagidæ; Byrrhidæ; Anisotomidæ; Phalacridæ; Trichopterygidæ; Scydmenidæ; Trogositidæ; Cucujidæ; Colydiidæ; Lathridiidæ.

SUB-SEC. III. *Monilicornes.* Antennæ more or less moniliform or bead-like; wing covers very short. Habits putrivorous.

Tribe 5. Short-winged scavengers. (*Putrivora brevipennata.*) BRACHELYTRA, Latreille.

Families: Staphylinidæ; Pselaphidæ.

SUB-SEC. IV. *Pectinicornes.* Antennæ pectinate or comb-toothed.

Tribe 6. Stag beetles.

Family: Lucanidæ.

SUB-SEC. V. *Lamellicornes.* Antennæ lamellate. Food-habits different in the two tribes.

Tribe 7. Lamellicorn dung-beetles. (*Excrementivora lamellicornia.*) SAPROPHAGA, MacLeay.

Families: Copridæ; Aphodiidæ; Geotrupidæ; Trogidæ.

Tribe 8. Lamellicorn leaf-beetles. (*Herbivora lamellicornia.*) THALEROPHAGA, MacLeay.

Families: Dynastidæ; Rutelidæ; Melolonthidæ; Cetoniidæ.

SUB-SEC. VI. *Serricornes.* Antennæ more or less serrate or saw-toothed. Food—habits various.

Tribe 9. Saw-horned wood-beetles. (*Lignivora serricornia.*) STERNOXI, Latreille.

Families: Buprestidæ; Elateridæ; Cebrionidæ.

Tribe 10. Aberrant wood-beetles. (*Lignivora aberrantia.*)

Families: Ptinidæ; Cupesidæ; Lymexylonidæ.

Tribe 11. Soft-winged carnivora. (*Carnivora mollipennata.*) MALACODERMI, Latreille.

Families: Lampyridæ; Melyridæ; Cleridæ.

FOURTH ANNUAL REPORT

ON THE

NOXIOUS AND BENEFICIAL INSECTS

OF THE

STATE OF ILLINOIS.

BY WILLIAM LEBARON, M. D.,
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INTRODUCTION.

[Fourth Report.]

To His Excellency, John L. Beveridge,
Governor of the State of Illinois:

Sir—I herewith transmit my fourth annual report upon the injurious and beneficial insects of the State of Illinois.

In this report I have carried out the plan proposed in the introduction to my last report, of continuing the work there commenced under the title of Outlines of Entomology, so far as to complete the order of Coleoptera or beetles. As stated in the introduction just referred to, my object in this undertaking is to simplify and facilitate the study of this extensive and difficult science, for the benefit of those who may be interested in it, and who, it may be presumed, will comprise a considerable number of the young people of the State, under the stimulus recently given to the prosecution of this class of studies by the legislative enactment which requires that the study of natural history shall constitute one of the branches of education to be taught in the public schools.

The continuation of this work, however, so as to embrace all the orders of insects, would require more time and study than could be devoted to them consistently with the proper discharge of the more directly practical duties of this office. I shall not therefore attempt to continue it any further, at least for the present. But as the study of the several orders of insects is, to a great extent, independent of each other, the present work, it is hoped, will be found equally useful to the student, so far as it goes, whether the remaining parts ever be completed or not. With the view of making the part now published as complete in itself as possible, I have appended to it a glossary of the scientific terms more commonly used in descriptive entomology, and also a list of the principal authors, in this branch of science, both European and American.

As the present report is a continuation of the preceding, or third annual report, and will undoubtedly fall into the hands of many who will be unable to procure copies of the other, I have reprinted, with some alterations, the concluding portions of the last report, which forms a natural introduction to the present.

I may here add that the lateness of the date at which the bill for the appropriation for the purpose of illustrating this report passed the General Assembly, and the time required for preparing the engravings, have necessarily caused a delay in the publication of this report of several months beyond the usual time.

I also deem it proper here to put on record, that the preparation of the above mentioned bill, and its passage through the General Assembly, were largely due to the interest and exertions of that well known friend of popular education, the Hon. Elmer Baldwin, of LaSalle county.

Respectfully submitted.

WILLIAM LEBARON,
State Entomologist.

GENEVA, *September* 1, 1874.

OUTLINES OF ENTOMOLOGY,

PUBLISHED IN CONNECTION WITH THE AUTHOR'S

ANNUAL REPORTS UPON INJURIOUS INSECTS.

PART FIRST.

INCLUDING THE ORDER OF COLEOPTERA.

BY WILLIAM LEBARON, M. D.,
STATE ENTOMOLOGIST OF ILLINOIS.

PREFACE.

It is the object of the present work to simplify and facilitate the study of entomology, and especially to aid the inexperienced student in classifying the insects which he may from time to time collect.

With this end in view I have made use, as far as practicable, of obvious and conspicuous characters in preference to those which are more minute and obscure, and consequently of more difficult application. I have therefore made much use of the general characters of size, shape and color, but only so far as could be done consistently with the established classification of insects, founded upon their more permanent organic characters.

In treating the Coleoptera, for the purpose of keeping in view the connection between scientific and practical entomology, I have endeavored to classify them, as nearly as possible, in accordance with their food-habits, it being in the nature of their food and their modes of procuring it that insects come into the most direct relation to human interests; and this arrangement does not materially differ, so far as relates to the larger divisions, from that already established by LATREILLE and other entomologists, mostly upon structural considerations. This mode of classification is particularly interesting and available in the order of Coleoptera, on account of their much greater diversity of habits in these respects, than that of any of the other orders of insects.

In classifying the Coleoptera I have not included a few small families, and a much larger number of small genera, thinking it best not to confuse the mind of the inexperienced student by the description of too many divisions, many of which contain but a few rare species, or else, are so similar to other and previously established genera that their separation is a matter of questionable utility. Neither have I been able, without greatly extending the size and scope of this work, to take into account many of the new species which have been brought to our knowledge by the recent explorations of the more western portions of the continent. The reader who wishes to extend his researches to these remote States and Territories, is referred more particularly to the various writings of Dr. LECONTE, and the revision of the Tenebrionidæ of North

America, and other memoirs, by Dr. GEO. H. HORN. But whenever a general enumeration of the species in any group is given, without qualification, it must be understood to embrace all the known North American species. In stating the numbers of species, I have followed, for the most part, the recently published Check List of Mr. G. R. CROTCH, (1874). Where two or more closely allied genera or sub-genera are merged in one, all the species are, of course, included under the leading generic title. A precise adjustment of species formed no part of my plan, and my principal object in giving these numbers has been to show the comparative numerical importance of the several families and their leading or typical genera.

In the definition of genera I have had constant reference to the great work of LACORDAIRE on the genera of Coleoptera*; and to Dr. J. L. LECONTE'S very accurate and scientific classification of the Coleoptera of North America, prepared for the Smithsonian Institution. (Part 1st, 1 vol., 8 vo., 1861; and Part 2d, 1873.) To these elaborate systematic works, and especially the latter, which, for obvious reasons, is most readily available to the American student, the present treatise is only intended to serve as an introduction or stepping stone; and to them the reader is referred for more extensive details, and for the definition of the smaller families and genera not included in the present work.

In the families Chrysomelidæ, Erotylidæ, Endomychidæ and Coccinellidæ, which have not been reached in either of the uncompleted works just referred to, I have derived valuable aid from the synopsis of these families by Mr. G. R. CROTCH, recently published in the Proceedings of the Academy of Natural Sciences of Philadelphia, and in the Transactions of the American Entomological Society.

In treating of the internal structure of insects I have necessarily limited myself to the briefest general statements. Those who wish to prosecute further this department of the science, will find much interesting matter in Dr. A. S. PACKARD'S well known Guide to the study of Insects.

It will be seen that some of the families of Coleoptera are much more fully treated than others. This has been owing, partly, to the greater amount of material at my command, partly to the comparative importance of certain families in a practical or economic point of view, and partly to the irregularity of the intervals at which the work has been prosecuted, which has prevented that uniformity of execution which would have been desirable.

In order to make this little work as useful as possible, I have added a glossary of the terms most commonly used in descriptive entomology; and also, a brief catalogue of authors, especially those whose names ap-

Genera des Coleopteras. Ten vols. 8 vo., Paris, 1854-1872. The author died before the completion of this work, and the tenth volume has not yet been published.

pear in connection with the descriptions of North American Coleoptera, or the elucidation of their natural history.

Much of the value of a work intended, like the present, for the inexperienced student, must depend upon accurately executed figures of the insects treated of, and the details of their organization. An appropriation for this purpose by the General Assembly has enabled me to illustrate the present work to a reasonable extent. Most of these figures have been drawn by Mr. C. V. RILEY, State Entomologist of Missouri, and engraved under his direction, which is a sufficient guarantee of their accuracy. Many of these have already been published in illustration of his own official reports, but a considerable number of them have been prepared originally for this work. A small proportion of the figures have been obtained from Dr. Packard's Guide to the study of Insects, from Westwood's Introduction, and a few from other sources.

The straight hair-line frequently placed at the side of a figure, shows the natural length of the insect.

SYSTEMATIC INDEX.

Sub-section VI. **Serricornes.**

TRIBE IX.

SAW-HORNED WOOD-BEETLES.

TRIBE X.

ABERRANT WOOD-BEETLES.

TRIBE XI.

SOFT-WINGED CARNIVORA.

Section II. *HETEROMERA :*

TRIBE XII.

PARASITIC-BEETLES.

TRIBE XIII.

HETEROMEROUS BARK-BEETLES.

TRIBE XIV.

HETEROMEROUS GROUND-BEETLES.

TRIBE XV.

HETEROMEROUS FUNGUS-BEETLES.

Section III. *TETRAMERA :*

TRIBE XVI.

SNOUT-BEETLES.

TRIBE XVII. PAGE.

SHORT-HORNED WOOD-BORERS.

TRIBE XVIII.

LONG-HORNED WOOD-BORERS.

TRIBE XIX.

TETRAMEROUS PLANT-BEETLES.

SYNOPSIS OF THE TRIBES OF THE COLEOPTERA.

A. Tarsi usually 5-jointed, sometimes 4 or 3-jointed in very small species, slender and sparsely haired, except Tribe XI, and except that the anterior, or anterior and middle tarsi are sometimes dilated and brush-like beneath in the males.

B. Elytra covering the whole or nearly the whole of the abdomen.

C. Antennæ filiform and simple; outer lobe of maxillæ palpiform, giving the appearance of six palpi.

D. Legs long and fitted for running, hind trochanters large, egg-shaped and prominent; tarsi always 5-jointed ....Tribe I.

D D. Hind legs flattened and fringed for swimming; trochanters not prominent; the fourth joint of the anterior and middle tarsi sometimes indistinct in very small species ....Tribe II.

C C. Antennæ filiform and usually serrate; outer lobe of maxillæ not palpiform.

E. Prosternum prolonged to a point behind and received in the mesosternum; body very firm, legs short, tarsi always 5-jointed, joints not dilated and brush-like beneath, but often furnished with membranous lobes on the under side...Tribe IX.

E E. Prosternum not prolonged behind.

F. Body moderately firm; legs more or less elongated; tarsi various: Tribe X.

F F. Body soft, elytra thin and flexible; tarsi usually somewhat dilated and brush-like beneath, with the fourth joint bilobed; last joint of palpi sometimes dilated..........................Tribe XI.

C C C. Antennæ clavate or capitate.

G. Palpi usually very long, sometimes longer than the short antennæ; antennæ 6 to 9-jointed, strongly clavate; middle and hind coxæ dilated; middle and hind tarsi sometimes fringed; habits aquatic. Tribe III.

G G. Palpi not elongated; antennæ 11-jointed, rarely 10 or 9-jointed; coxæ not dilated; habits not aquatic.

H. Club of antennæ pectinate; mandibles usually strongly toothed or even branched; size large, or medium ....Tribe VI.

H H. Club of antennæ lamellate; size often large; sometimes small, but never very small.

I. Abdomen wholly covered by the elytra (except Copridæ); hind legs set far back................................Tribe VII.

I I. Tip of abdomen exposed; hind legs not set far back. Tribe VIII

H H H. Antennæ clavate, but with the club neither pectinate nor lamellate, and nearly or quite filiform in the exceptional group of Sub-clavicornes; size small or very small, (except Silphidæ).....................................Tribe IV.

B B. Elytra much shortened, usually covering less than half of the abdomen; antennæ more or less moniliform ....Tribe V.

A A. Anterior and middle tarsi 5-jointed, hind tarsi 4-jointed; the joints slender, sparsely haired or spinous, sometimes silky or pubescent beneath, but never dilated, brush-like and bilobed as in the remaining sections; except sometimes the penultimate joint in parts of Tribes XII and XIII.

K. Head as wide as the thorax, and attached to it by a neck; body rather soft and elytra flexible; antennæ filiform, sometimes serrate or pectinate; anterior coxæ prominent and contiguous; colors various, and often diversified; larvæ usually parasitic..Tribe XII.

K K. Head narrower than the thorax, and usually partly inserted in it; body firm; color black or brown; rarely diversified.

L. Antennæ filiform; anterior coxæ somewhat prominent, and nearly or quite contiguous; color mostly brown, sometimes black; larvæ sub-cortical. Tribe XIII.

L L. Antennæ sometimes filiform, but usually more or less clavate; anterior coxæ small, depressed, and never contiguous.

M. Antennæ usually moderately and gradually enlarged towards the tip, but sometimes filiform, and usually as long as the head and thorax; body oblong; color black or dark metallic; larvæ mostly terrestrial. Tribe XIV.

M M. Antennæ usually short and perfoliate; body short, oval or subquadrate; color brown, or black with red spots, sometimes metallic; larvæ fungivorous ....Tribe XV.

A A A. Tarsi apparently 4-jointed, with all the joints, except the last, dilated, brush-like beneath, and with the penultimate joint usually bilobed, (except Scolytidæ.)

N. Head more or less prolonged into a snout or rostrum; antennæ usually capitate; larvæ fructivorous ....Tribe XVI.

N N. Head not prolonged into a snout.

O. Antennæ clavate or capitate; tarsi not dilated; form sub-cylindrical; size small; color brown or black; larvæ lignivorous...Tribe XVII.

O O. Antennæ usually filiform or setaceous; sometimes slightly widened towards the tip; tarsi always dilated and brush-like beneath, with the penultimate joint usually bilobed.

P. Form elongated; antennæ almost always long, and filiform or setaceous; often as long as the body or longer; size and colors various; larvæ lignivorous..........................Tribe XVIII.

P P. Form short, and more or less oval; antennæ filiform, or a little thickened towards the end, and never much more than half as long as the body; size below medium or small; colors various; larvæ herbivorous ....Tribe XIX.

A A A A. Tarsi usually apparently 3-jointed, sometimes 4 or 5-jointed, the joints dilated and brush-like beneath, with the penultimate joint usually deeply bilobed; antennæ usually strongly clavate, rarely sub-clavate.

Q. Form oval or oblong; antennæ of moderate length; colors red and black, usually arranged in large spots or stripes; habits fungivorous ...Tribe XX.

Q Q. Form rounded, or sub-hemispherical; antennæ very short; colors mostly red and black, arranged in dots; habits carnivorous ....Tribe XXI.

NAMES OF THE TRIBES IN THE FOREGOING TABLE.

OUTLINES OF ENTOMOLOGY.

INSECTS IN GENERAL.

Insects constitute the most numerous and diversified class of the second grand division of the animal kingdom, designated by the term ARTICULATA, and so called because their bodies and limbs are composed of many pieces, connected together by movable joints or articulations.

Insects as a class, and in the widest meaning of the word, comprise three divisions, or sub-classes, commonly known as Spiders, Insects and Millipedes. They may be distinguished by the following characters:

1st. Sub-class: ARACHNIDA, including Spiders, Scorpions and Acari, or Mites. Body divided into two parts, the head and thorax being united in one; legs eight in number; without wings.

2d. Sub-class: INSECTA, or Insects proper. Body divided into three parts, the head, the thorax, and the abdomen; legs six; furnished with wings, in the perfect or *imago* state.

3d. Sub-class: MYRIAPODA, commonly called Millipedes or Centipedes. Body divided into many parts or segments, varying from ten to two hundred; legs numerous; usually either one or two pairs of legs to each segment of the body; never have wings.

The exceptions to these characters are very few. In the Arachnida, some of the most minute Acari have but six legs.

Insects proper are always six-legged in their last or perfect state, and they also generally have six true legs in their larva state; but some larvæ have no legs, and the larvæ of the Lepidoptera, commonly called caterpillars, have, in addition to their six true legs, several pairs of false legs, or pro-legs, which assist in locomotion.

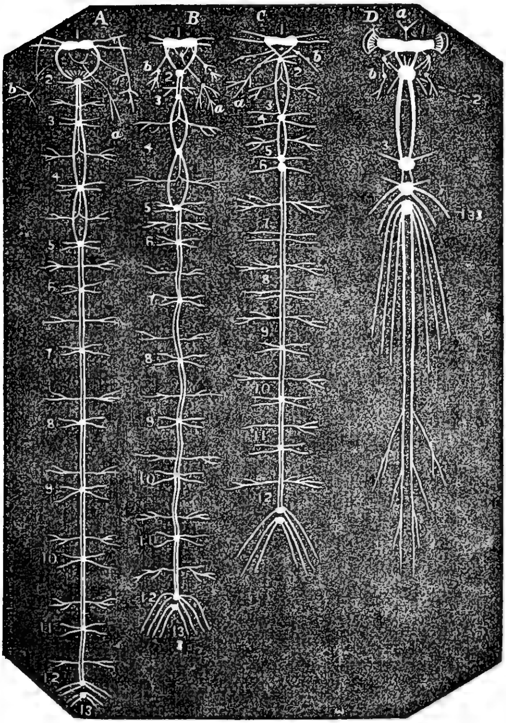
There are a few exceptional cases in which insects are destitute of wings. The Fleas (Pulices), the Lice (Pediculi), and the little family of insects known as Spring-tails (Thysanoura), never have wings. In some rare instances the females are wingless, whilst the males have wings. This is the case with some species of the Lightning-beetles (Lampyridæ), and with the Canker-worm moth, and the Tussock-moth, and a few other species amongst the Lepidoptera. Similarly exceptional cases are also found in other orders of insects.

The present work will treat only of Insects proper.

INTERNAL STRUCTURE OF INSECTS.

THE NERVOUS SYSTEM.

[Fig. 1.]



Nervous system of insects, explained in the text.

The nervous system of insects consists of a double cord extending the length of the body, and lying upon the inferior or ventral side of the internal cavity. The two threads which compose this cord do not lie side by side, but one above the other. The lower thread swells at intervals into little knots of nervous matter, called ganglia. In insects of an elongated form, such as some of the Neuroptera (e. g. Corydalis), and the larvæ of the Lepidoptera, there is a ganglion at each segment of the body, making thirteen in all; but in most mature insects the ganglia become more or less consolidated. In the Butterfly (Papilio), there are ten ganglia, counting the brain as one; in the Bee (Apis), there are eight; in the May-beetle (Melolontha), there are five, and in the Cicada there are but two. The upper of the two nervous threads runs nearly in contact with the lower, but is destitute of ganglia. These two threads seem to represent the double and more compact cord which constitutes the spinal marrow of the higher or vertebrated animals. The upper simple thread is supposed to furnish the nerves of motion, and the lower and ganglionic thread, the nerves of sensation. The fibres which compose these cords separate at the anterior extremity of the body, so as to embrace the œsophagus or gullet, above which they again unite to form the cerebral ganglion or brain, which is somewhat larger than the other ganglia. From the nervous cords, and chiefly from the ganglia, fine lateral threads are emitted, which are distributed to the adjacent parts.

The nerves thus far described represent what, in the higher animals, is called the cerebro-spinal system of nerves, and are sometimes called

the nerves of relation, because they control the sensations and motions which associate the animal with the world around it. But in addition to these, there have been discovered a number of very fine nervous filaments proceeding from the brain, and extending down into the body, and furnished with minute ganglia of their own, which are supposed to represent the sympathetic system of nerves which preside over the internal functions, such as those of digestion and secretion.

The foregoing cut represents the nervous system of a butterfly, (*Papilio brassicæ*—after Herold), A exhibiting that of the larva, B that of the pupa, and C that of the perfect insect; and showing how the nervous system becomes shortened and consolidated in changing from the lower to the higher stages. Fig. D. shows the more concentrated nervous system of a Coleopterous insect, as exhibited in the common English Cockchafer or door-beetle, *Melolontha vulgaris*, (copied from Straus.)

THE CIRCULATORY, OR SANGUIFEROUS SYSTEM.

The blood of insects is a colorless fluid, which does not circulate in closed vessels or tubes, like that of the higher animals, but permeates the tissues of the body. The only vessel that can be discovered is an oblong, membraneous, pulsating sack, situated in the upper or dorsal part of the body, and which evidently represents the heart. This is divided into several compartments by cross-valves, which are so arranged as to permit the blood to pass only in a forward direction. The heart is prolonged anteriorly into a narrower tube analogous to the aorta. Through this the blood flows first towards the head, and thence through the body, returning to the heart, which it enters through openings at its sides. As compared with that of the warm-blooded animals, the blood of insects is not only colorless, but small in quantity, and must circulate very slowly, as is proved by the fact that when their bodies are wounded no blood escapes.

THE RESPIRATORY SYSTEM.

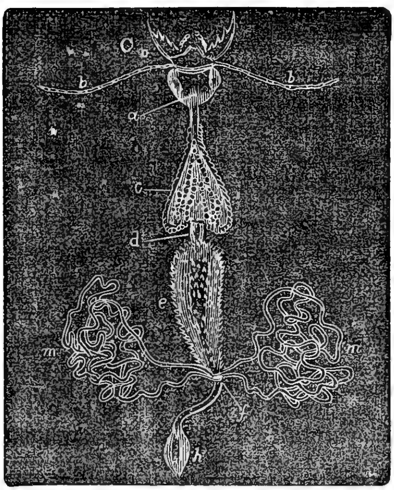
Most of the organs of insects, and their functions, have an obvious analogy to those of the higher animals, but their breathing apparatus is constructed upon an entirely different plan. In all the vertebrated animals the blood is carried in vessels to a particular part or organ of the body, for the purpose of being exposed to the life-giving influence of the air. This part in terrestrial animals, is the lungs, and in aquatic animals the gills. But in insects the process is reversed, and the air is carried to the blood by being distributed to every part of the body in very delicate pearl-white tubes or vessels, which present a beautiful appearance under the microscope. They are called tracheæ, or air tubes. They admit the air through little openings along the sides of the in-

sect's body, called spiracles. The spiracles or breathing pores can be easily seen along the sides of all caterpillars which are not too densely covered with hairs. In the perfect or winged state of insects the branches of the air tubes are dilated into a great number of little vessicles or air bladders, which render their bodies lighter, and thus facilitate their flight.

In some aquatic larvæ the tracheæ project from the body in the form of little tufts, analogous to the gills of fishes. The aquatic beetles are under the necessity of rising to the surface, at intervals, for air, in a manner similar to that of the aquatic mammalia, the whales and the dolphins.

THE DIGESTIVE OR NUTRITIVE SYSTEM.

[Fig. 2.]



Digestive organs of insects, explained in the text.

The digestive apparatus of insects, like that of other animals, consists of an elongated tube called the alimentary canal, extending through the body, and having a number of enlargements in its course, and in many insects presents a particular resemblance to the digestive apparatus of birds. First, there is a short, straight œsophagus or gullet; this expands into a much larger cavity, resembling the crop; then follows a smaller muscular part, analogous to the gizzard; and next, a much larger and longer cavity, which is the true digestive stomach; this becomes contracted into the intestinal canal, which sometimes runs nearly straight through the body, and in other cases is more or less convoluted; the intestine enlarges again before it reaches the end of the body into what is known as the large intestine or colon. As in other animals, the alimentary canal is much longer and more capacious in the herbivorous than in the carnivorous kinds. As a general rule the canal is much more capacious in the larva than in the imago state.

In Fig. 2, *C*, represents the digestive organs of one of the carnivorous beetles, *Cicindela campestris; a* the commencement of the œsophagus or gullet; *c* the crop; *d* the gizzard; *e* the stomach or principal digestive cavity; *f* the commencement of the small intestine; *h* the large intestine; both of these parts are unusually short in this tribe of insects; *m m* the convoluted vessels which are supposed to represent the liver of the higher animals.

THE SECRETORY SYSTEM.

The secretory apparatus of insects, though analogous in function, is very different in appearance from that of the higher animals. Instead of solid glands, like the liver or kidney, it has the form of masses of convoluted tubes, as represented at *m* in the preceding figure. The salivary glands, the liver, the kidneys, and the testacles are found represented in insects. The gastric and pancreatic fluids are secreted by little cells or follicles in the coats of the stomach.

THE MUSCULAR SYSTEM.

The muscles of insects, like those of other animals, consist of contractile fibres, but in their situation and attachments, as compared with those of the vertebrate animals, they are reversed; that is to say, in the latter, the muscles are situated outside of, and upon the bones, which constitute the supporting part of the body, whereas in insects, the supporting part is the external crust, and the muscles are attached to its internal surface. The muscles are of a pale yellowish color, and are usually presented in the form of thin layers, and sometimes of isolated fibres, and are never united into the rounded compact form which they have in the higher animals. By counting the separate fibres, a very great number of muscles have been enumerated. Lyonet counted nearly four thousand in the larva of *Cossus ligniperda*, and Newport found an equal number in the larva of *Sphinx ligustri*. The muscles of insects possess a wonderful contractile power in proportion to their size. A flea can leap two hundred times its own length, and some beetles can raise more than three hundred times their own weight. This remarkable strength may probably be attributed to the abundant supply of oxygen by means of the myriad ramifications of the air tubes.

THE ORGANS OF THE SENSES.

Insects are evidently endowed with the ordinary senses which other animals possess, but no special organs of sense, except those of sight, have been discovered with certainty.

Sight.—The eyes of insects are of two kinds, simple and compound. The simple or single eyes are called *ocelli*, and may be compared in appearance to minute glass beads. They are usually black, but sometimes red, and are generally three in number, and situated in a triangle on the top of the head. In insects with a complete metamorphosis, these are the only kind of eyes possessed by them in their larva state, and in these they are usually arranged in a curved line, five or six in number, on each side of the head. We have noticed that in some insects which undergo only a partial metamorphosis, as for example the common

Squash-bug *(Coreus tristis)*, the ocelli are wanting in the larva and pupa states, but become developed in the last or perfect stage.

The compound eyes of insects present one of the most complex and beautiful mechanisms in the organic world. They are two in number, but proportionately very large, occupying in many insects nearly the whole of the sides of the head, and, in the dipterous order especially, often present across their disks, bands of the richest tints of green, brown and purple. These eyes are found to be composed of a great number of lesser eyes or eyelets, in the form of elongated cones so closely compacted as to form apparently a single organ. The larger ends of these cones point outwards, and by their union form the visible eye. Their smaller extremities point inwards, toward the brain, to which they are connected by means of a large optic nerve. When one of these eyes is examined through a strong magnifying glass, it is seen to be composed of a very great number of little facets, sometimes square, but usually six sided, each one of which represents the outer and larger extremity of one of the component parts. These facets vary greatly in number in the eyes of different kinds of insects. In the ants there are about fifty in each eye; in the Sphinx moths, about 1,300; in the house fly, 4,000; in the butterfly, upwards of 17,000; and in some of the small beetles of the genus Mordella, it is said that more than 25,000 facets have been enumerated in one compound eye; so that if we suppose that each of these component parts possesses the power of separate vision, one of these insects must have more than 50,000 eyes. How vision is effected, or how a unity of impression can be produced by so complex an organ, we are unable to conceive.

Hearing.—Insects are evidently affected by loud noises, and moreover, as many insects have the power of producing voluntary sounds, it is reasonable to suppose that they possess the sense of hearing. No organ, however, which has been generally admitted to be an organ of hearing, has been discovered. It is the most common opinion of entomologists that the antennæ are instrumental in receiving the impressions of sound, and that the sense of hearing is located at or near their place of attachment to the head, and this view is much strengthened by the fact that in some of the larger crustaceans, such as the lobster and crab, a distinct organ of hearing is found located at the base of the antennæ.

Smelling.—That insects are endowed with the sense of smell, is proved by the fact that the carrion-fly, and other insects which feed upon, or deposit their eggs upon, putrescent matter, detect such substances at a distance, however completely they may be hidden from the sight. The bee also discovers honey under similar circumstances, and it is therefore fair to presume that insects are conducted to flowers, in hidden situa-

tions, more by their odor than by their visible characters. But no organ of smelling has been discovered, and this sense is supposed, from analogy, to be located in the lining membranes of the spiracles.

Taste and Touch.—It is impossible to determine, but there is no reason to doubt, that insects, like other animals, taste and enjoy the food of which they partake; and the manner in which they frequently touch their food, and the surfaces over which they walk, with the tips of their palpi, which, indeed, have received the common name of *feelers*, renders it probable that these organs are endowed with a special sense of touch.

SOUNDS PRODUCED BY INSECTS.

The songs of birds, and the noises made by other animals, are produced by the forcible passage of air through the glottis, which is the narrow opening at the top of the wind pipe, aided by the vibration of certain muscular folds near the outlet, called the vocal chords. But we have seen that insects never breathe through their mouths, and therefore they never make any oral sounds. But the humming of bees and flies is produced in an analogous manner, by the expulsion of air through the thoracic spiracles, and the vibration of a delicate valve-like fold, just within the opening.

But besides this, insects make a variety of noises, which are produced in different ways. The singing of the Cicada, which is the loudest noise made by any insect, is produced by the expulsion of air from the first abdominal spiracle, striking upon a large transparent drum-like apparatus, situated at the base of the abdomen. The chirping of crickets is produced by rubbing together their parchment-like wing-covers. The well-known noise of the katy-did is produced in the same way, but here the sound is intensified by a thin talc-like plate set into the base of each wing-cover. The stridulation of grasshoppers is caused by the friction of their spined shanks across the edge of their wing-covers. The fainter, squeaking sounds, made by many insects when captured, are produced simply by the rapid friction of one part of their bodies upon another; in certain Hemiptera, by the friction of the head upon the pro-thorax; in the Capricorn beetles, by the friction of the pro-thorax upon the meso-thorax; and in some of the Lamellicorn beetles, by the friction of the abdomen against the wing-covers.

The more complex and special apparatuses of insects for the production of sounds, are possessed exclusively by the males, and are supposed to be exercised by them as calls to the opposite sex; but the simpler squeaking sounds are emitted by both sexes, and appear to be mere notes of alarm.

THE METAMORPHOSES OF INSECTS.

Nothing in the history of insects is more remarkable than the striking changes of form which many of them undergo, in the course of their development. Whilst other animals progress from infancy to maturity, simply by a process of growth, and by such gradual and imperceptible changes only as their growth necessitates, many insects assume totally different forms in the course of their development, so that they could never be recognized as the same individuals, if this development had not been actually traced from one stage to another. These changes are called the *metamorphoses* or *transformations* of insects. All insects, in their growth, pass through four stages, designated as the *egg* state; the *larva*, or caterpillar state; the *pupa*, or chrysalis state; and the *imago*, or perfect and winged state. The metamorphoses of insects are of two principal kinds, *complete* and *incomplete*.

In the *complete* metamorphosis the larva bears no resemblance to the imago, and the insect, in the intermediate or pupa state, is motionless, and takes no food. This kind of metamorphosis presents two principal varieties. In some (Lepidoptera and many Diptera), the legs and wings are completely inclosed in the pupa case. In others (Coleoptera, Hymenoptera, and some others), the legs of the pupa, though useless, are free, and the rudimental wings lie loosely upon the sides. Moreover, in some (the noctural Lepidoptera, and many Hymenoptera), the pupa is inclosed in a separate covering or cocoon, whereas the majority of insects have no such covering. Pupæ thus inclosed are called *folliculate*. The term *chrysalis*, from a Greek word meaning *golden*, is sometimes applied to the pupæ of the diurnal Lepidoptera, because the pupæ of some butterflies are ornamented with golden spots.

Most insects, in changing from the larva to the pupa state, cast off the larval skin, but in many of the two-winged flies, (Muscidæ, Syriphidæ, etc.) the larval skin becomes contracted and hardened, assumes an oval form and a brown color, and thus forms a compact and closely-fitting case, in which the pupa proper is inclosed, but distinct. Pupæ thus inclosed are called *coarctate*, and their cases are analogous to the cocoons of the Lepidoptera.

In the *incomplete* metamorphosis, the insect presents essentially the same form, and is active in all its stages, after leaving the egg. The pupa is distinguished from the larva by the presence of short rudimental wings at the base of the abdomen, and the imago or adult state is distinguished by the fully grown wings and wing-covers. It is only in this last stage that insects are capable of propagation. All the Hemiptera, or bugs proper, and all the Orthoptera, or crickets, grasshoppers and cockroaches, exhibit this imperfect kind of metamorphosis.

In treating of the development of insects it is necessary to refer to the periodical casting of the larval skin. All the growth of insects takes place in the larva state. Consequently no insect increases in size after it has acquired wings. The larval skin seems to be an imperfectly organized membrane, which does not correspond in its growth to that of the body, but yields to this growth, to a certain extent, by virtue of its elasticity. A time comes therefore when it can yield no farther. The insect then evidently becomes oppressed, ceases to eat, usually retires to some secluded spot, and, if gregarious, huddles together with its companions, and there remains a day or two, almost motionless and without food, and in an apparently torpid and sickly condition. After a time the distended skin bursts open, and the insect throws it off, and appears in a new, bright, and elastic skin, which, in its turn, is capable of a certain degree of distension. This process, which is called *moulting*, takes place three or four times in the course of the larval growth, and in a few larvæ which continue more than one year in this state, the moulting is said to occur from five to eight times. In insects of very rapid development, on the other hand, such as the maggots, or larvæ of the Muscidæ, no moulting takes place, and it is the larvæ of this kind which form coarctate pupæ.

THE SEXES OF INSECTS.

As a general rule insects of different sexes resemble each other so closely as to leave no doubt of their specific identity, and in many the sexes can scarcely be distinguished. But this rule is subject to many exceptions, and the naming of insects has been greatly confused by the sexes of the same insect having been described and named as distinct species.

The sexual organs, especially those of the males, are usually concealed so as to be nearly or quite invisible; but the female, especially in the order of Hymenoptera, often have an exserted ovipositor of greater or less length, which readily distinguishes them from the opposite sex. An analogous structure exists in many wood-boring beetles which deposit their eggs in deep crevices in the bark of trees; and more rarely in insects of the other orders. In the Coleoptera the males are sometimes distinguished by one or two horns, either upon the head or thorax, and many of the predaceous beetles, both terrestrial and aquatic, have the anterior feet much widened, and furnished beneath with a cushion of hairs or bristles.

The antennæ usually differ in length but little, if at all, in the two sexes; but in the long-horned beetles (Cerambycidæ) the antennæ of the males are generally considerably longer than those of the females.

In those moths which have bi-pectinate antennæ, these parts are almost always wider in the males. Many insects in the order of Diptera are remarkable for the great size and beauty of their eyes, and these organs are almost always larger in the males than in the females.

♂ ♀ In describing insects it is customary, for the sake of brevity, to distinguish the sexes by signs, as shown in the margin.
male. female.

EXTERNAL STRUCTURE OF INSECTS.

The classification of insects depends chiefly upon the structure of the external and visible parts. It is necessary therefore that the student should have a thorough knowledge of these parts and of the names by which they are designated. But as these parts are very greatly modified in the different orders of insects, we shall reserve a minute description of them till we come to treat of them in connection with the several orders respectively, and shall here give only a general enumeration of them. The student will be much aided in understanding the following description by comparing it with the figure of *Harpalus caliginosus* on a subsequent page.

THE HEAD AND ITS APPENDAGES.

It often becomes necessary to refer to different parts of an insect's head, and they are therefore designated by particular names indicative of their situation. These are—

The Hind-head, (*Occiput*). The Crown, (*Vertex*). The Fore-head (*Frons*). The Face, (*Facies*). The Cheeks, (*Genæ*).

The appendages of the head are the Horns, (*Antennæ*); the Eyes, (*Oculi*); and the parts of the Mouth, (*Trophi*, or *oral organs.*)

The *Antennæ.*—All insects have two more or less elongated and usually many-jointed antennæ situated one on each side of the head, and varying greatly, in different kinds of insects, in length and in the form of their component joints. Insects have very short antennæ in their larva state, and in some perfect insects, such as the water-beetles, (*Gyrini* and *Hydrophili*), the antennæ are not longer than the head, whilst in others, such as some of the longicorn beetles, they are more than twice as long as the whole body, and in some of the small moths of the genus *Adela*, they are five or six times as long. The uses of the antennæ are not known, but, as we have stated above, when treating of the senses of insects, they are supposed to be instrumental in the sense of hearing. The most common variations in the forms of the antennæ are expressed by the following terms. Figures of most of these forms are given on a subsequent page, in treating of the Coleoptera.

Filiform, or *thread-like;* long and slender, and of the same, or nearly the same width throughout.

Setiform, or *setaceous; bristle-like;* long and slender, but tapering towards the tip.

Moniliform, or *bead-like;* when the joints are about the same size, and round, so as to resemble a string of beads.

Serrate, or *saw-toothed;* when each joint is somewhat triangular, and a little prominent and pointed on the inner side.

Pectinate, or *comb-toothed;* when the inner angles of the joints are considerably prolonged.

Bi-pectinate, or *double comb-toothed;* pectinate on both sides.

Clavate, or *club-shaped;* gradually enlarging towards the tip.

Capitate, or *knobbed;* when a few of the terminal joints are abrubtly enlarged.

Lamellate; when the joints which compose the knob are prolonged on their inner side, in the form of plates.

The *Eyes.*—We have briefly described the mechanism of the eyes when treating of the sense of sight. They are uniformly of a round or oval shape, and sometimes notched on their inner side, to give place for the insertion of the antennæ. In a few instances they are placed at the end of foot-stalks made by a lateral prolongation of the head.

The *Trophi*, or parts of the mouth.—The mouths of insects present two strongly marked variations, one of which is fitted for gnawing solid substances, and is called the *mandibulate*, or gnawing mouth; and the other is fitted for sucking fluid nutriment, and is called the *haustellate*, or suctorial mouth.

The mandibulate mouth is composed of six pieces, more or less distinct, and their appendages. First, the *labrum*, or upper lip: a horny, usually somewhat semi-circular plate, attached to the anterior and inferior edge of the head, and serving to close and protect the mouth in front.

Then, the *Mandibles*, or upper jaws; a pair of very hard, horny pieces, more or less hooked at the point, and often toothed on their inner sides, which work together laterally, somewhat like the blades of a pair of scissors. These are the true biting, gnawing, or masticating organs.

Next are the *Maxillæ*, or lower jaws; a pair of organs, working laterally like the mandibles, but softer and more pliable in their texture, generally divided into two lobes at their extremity, which are furnished more or less with hairs. The maxillæ undoubtedly assist in the operation of eating, but the precise part which they perform is not well understood.

Behind the maxillæ is a single piece which partially closes the mouth behind, and which may therefore be considered as the counterpart of the labrum or upper lip, and is accordingly called the *labium*, or lower lip,

In the Coleoptera this piece is usually attached at its base to the anterior face of an elevated ridge upon the under side of the head, which

forms a kind of wall behind the mouth, usually deeply notched in the middle, and which is called the *mentum*, or chin.

When the labium forms a narrow elongated piece, distinct from the mentum, as in most of the Coleoptera, it is now generally called the tongue, *lingua* or *ligula.*

The *Palpi*, or appendages of the mouth.—Near the base of each maxilla, on its outer side, is attached a movable appendage, usually composed of four or five joints, and never more than six, called the *maxillary palpus ;* and near the base of the labium is attached a similar pair of organs, but with a less number of joints, distinguished as the *labial palpi.* These appendages are subject to considerable variation especially in the shape of their terminal joints, and are made much use of in determining the families and genera of insects.

The *haustellate* or *suctorial* mouth consists of a more or less elongated proboscis or sucker, which is sometimes short and fleshy, as in the flies, (*Muscidæ ;*) sometimes more elongate, horny and pointed, as in the bugs, (*Hemiptera ;*) and sometimes very long and slender, and rolled up, when not in use, in a spiral coil, as in the butterflies and moths, (*Lepidoptera.*)

It is evident that all insects with a suctorial mouth must live exclusively upon liquid food, or the juices of animals and plants.

The *haustellum* or sucker is not a single organ, as it appears, but has upon its upper side a deep groove, in which are contained usually either two or four, but in some of the carnivorous species (mosquitoes and horse-flies) six needle-shaped pieces, which in these last make a complicated weapon with which they pierce the skins of animals upon whose blood they subsist.

From a comparison of the haustellate with the mandibulate mouth, in different kinds of insects, it has been concluded that the apparent sucker, which, as we have just seen, forms a sheath for the smaller needle-shaped pieces, corresponds to the labium, and that the contained pieces must represent the mandibles and maxillæ, and, where six pieces are present, also the labrum and lingua. In accordance with the proportionately great development of the labium, we find that its appendages, that is, the labial palpi, are also very prominent, whilst the maxillary palpi are very small or rudimental. This is the case in two of the suctorial orders, the Lepidoptera and Diptera ; but the other order (Hemiptera) is exceptional in this respect, having neither maxillary nor labial palpi developed.

THE THORAX AND ITS APPENDAGES.

The thorax is the second, or middle division of the bodies of insects. Though apparently single, it is really composed of three pieces soldered

together. These pieces are more distinct in some insects than in others, but they can always be distinguished by impressed lines upon the surface called *sutures.* The three pieces of the thorax are distinguished as the fore-thorax, the middle-thorax, and the hind thorax; or, in scientific language, the *pro-thorax*, the *meso-th rax*, and the *meta-thorax.* In the Coleoptera the pro-thorax is very large, and forms the large upper part, or shield, to which we usually give the general name of thorax. In this order of insects, the meta-thorax is invisible above, and the only part of the meso-thorax seen from above is the triangular piece between the bases of the elytra, called the *scutellum.*

In many insects (*Hymenoptera* and *Lepidoptera*) the pro-thorax is mrch reduced in size, and forms only a narrow rim, which is usually called the *collar.*

The under side of the thorax is called the *sternum* or breast plate. Each of the three divisions of the thorax has its sternum, designated respectively as the *pro-*, *meso-* and *meta-sternum.* In many insects, and especially the Coleoptera, each section of the sternum is divided by sutures into a middle piece or *sternum* proper, and a side piece, called the *episternum.* These parts will be described more particularly in treating of the Coleoptera.

The *appendages* of the thorax are the organs of motion, namely, the *wings* and the *legs.*

The *Wings.*—The great majority of insects have four wings. The anterior pair are attached to the upper part of the meso-thorax, and the posterior pair to the meta-thorax.

The wings are thin, membraneous, transparent organs, in some cases folded when at rest, and supported by ribs or veins running across them. These veins are found to correspond in their number and complexity to the rank of the insect in the scale, and from the ease with which they can be seen, they furnish admirable characters for the purposes of classification. In some insects, such as the grass-hoppers, the fore-wings are thicker and less transparent than the hinder pair, and have nearly the consistency of parchment; and in one large order of insects, the Coleoptera or beetles, the fore-wings become converted into the hard opaque pieces, known as the *elytra* or wing-cases. The elytra take no part in flight, but serve only to cover and protect the hinder or true wings, which are folded under them when at rest.

In one large order, the insects have but two wings, and are named from this character *Diptera*, or two-winged insects. In these insects the place of the hind-wings is supplied by a pair of little knobbed appendages called *halteres* or poisers.

There are a few exceptional cases of two-winged insects in some of the other orders—for example, some of the smaller Day-flies (*Ephemeræ*) in the order of Neuroptera, and the males of the Bark-lice (*Coccidæ*) in the order of Homoptera.

The Legs.—Insects have six legs, attached in pairs to the under side of each of the three segments of the thorax. The leg consists of four principal parts; the hip (*coxa*), a short piece by which the leg is attached to the body; then an elongated piece called the thigh (*femur*, plural *femora*); then another elongated piece called the shank (*tibia*); and lastly the foot (or *tarsus*), which is composed of a number of smaller pieces or joints; of which five is the largest and most common number.

The feet of insects terminate, almost invariably, in a pair of sharp horny claws (*ungues*); and between these, at their base, is often one or two little pads (*plantulæ*) by means of which flies and many other insects adhere to glass, or any other surface which is too smooth and hard for the claws to catch upon. The Lepidoptera have but one plantula, and the Diptera have two. Besides the parts of the leg here enumerated, there is a small piece attached to the hind part of the hip, called the *trochanter*. This is usually small and inconspicuous, but in the hind legs of the ground-beetles (*Carabidæ*) it forms a large egg-shaped appendage, which is one of the most characteristic features of this family of insects.

THE ABDOMEN, AND ITS APPENDAGES.

The abdomen is the hindermost of the three divisions of an insect's body. It is sometimes attached to the thorax by the whole width of its base, in which case it is called *sessile*. But it is often attached by a slender petiole or foot-stalk, when it is said to be *petiolated*. The abdomen is composed of a number of rings, one behind another, each ring usually lapping a little upon the one following it. The normal number of rings or segments of the abdomen is considered to be nine, and this number is actually present in the Earwig (*Forficula*) and a few other insects; but in the great majority of insects, several of the terminal segments are abortive, and only from five to seven can usually be counted.

In the females of many kinds of insects the abdomen terminates in a tubular, tail-like process, through which the eggs are conducted to their place of deposit, and which is therefore called the *ovipositor*. In some insects the ovipositor is simple, short, straight and stiff, as in some of the Capricorn beetles; but in others, as the Ichneumon flies, it is long, slender and flexible, and composed of three thread-like pieces, which when not in use, are separated from each other, giving these insects the appearance of being three-tailed.

CAPTURING AND PRESERVING INSECTS.

Insects which do not readily fly, such as the beetles and the bugs proper (*Hemiptera*), can be captured with the fingers, and are easily

killed and also preserved, for the time being, by dropping them into alcohol. For this purpose every collector should have in his pocket one or more small, strong, wide-mouthed bottles, securely corked, and filled about two-thirds full with alcohol. The common morphine bottles answer this purpose very well. The quinine bottle can be used when a larger bottle is required. The insects can be left in the alcohol till the collector has leisure to pin them. They can be taken from the bottle with a pair of forceps, or the alcohol can be turned off into another bottle, and the insects shaken out on to a newspaper, or what is better, a sheet of blotting paper, which readily absorbs the moisture.

Insects which readily take flight, must be captured in a net, which is made like a small dip-net for fishes, by making a hoop of stout wire about ten inches in diameter, with the ends of the wire turned out so as to form a short handle three or four inches long, and this can be lengthened by inserting the ends of the wire into a wooden handle about two feet long. The net is made of lace or tarleton muslin, and should be twenty inches or more in depth.

Many species which would otherwise escape notice, can be obtained by beating the branches of trees, especially forest trees, and catching the insects as they fall. A common umbrella, inverted under the tree, answers this purpose very well. This is in many ways a very useful implement to the collector. It will serve to protect him from the direct rays of the sun, or from a casual shower; and the hook at the end of the handle will enable him to draw down branches so that they can be satisfactorily examined. The umbrella would be improved by being covered with white cloth, upon which small insects would be more easily detected.

Most insects except those above mentioned are injured by being immersed in alcohol, and butterflies and moths would be ruined by it. These insects can be killed by wetting them with benzine or chloroform. The benzine is the cheaper, and the only objection to it is its disagreeable odor. Large insects require to be saturated with chloroform several times to destroy life. A very neat way to kill the smaller moths is to put them under a wine-glass and put in with them a tuft of wool saturated with chloroform. The moths are killed by the fumes, without being wet or handled. Some use for this purpose a poisonous preparation called cyanide of potassium.

In mounting beetles the pin should be passed through the right wing-cover; other insects are pinned through the thorax. The pin should be inserted so far that half of it will project below the body of the insect.

The value of a collection of insects is greatly enhanced by having the legs and wings of the specimens displayed in a life-like attitude. For this purpose they must be set out with pins, and held so a day or two till they have become fixed. For spreading the wings of butterflies and

moths it is indispensable to have a simple apparatus called the *stretcher*. It consists of two strips of nicely dressed soft pine wood, 18 or 20 inches long, two inches wide, and about three-eighths of an inch thick, placed side by side, half an inch apart at one end and a quarter of an inch at the other, so as to accommodate insects of different sizes, and held so by a cleet across each end. The space between the strips must be closed on the underside by pieces of sheet cork tacked to the board. The space between the strips is to receive the body of the insect, the pin being passed through the cork so as to bring the wings on a level with the upper side of the stretcher. The wings are spread by catching them just behind the stout front rib with a pin, or, what is better, a needle set into a little handle, and carrying them forward, till the hind margin of the fore-wings are on a straight line with each other. They can be held in this position either by strips of card laid across them and fastened with pins, or by inserting a single small pin through the wing, behind the rib, and into the side pieces of the stretcher, which on this account should be made of the softest kind of wood. For very small moths the stretcher must be constructed upon a smaller scale.

Insects must be allowed to dry thoroughly before inclosing them in the cabinet. Beetles which have been permitted to dry with their limbs contracted, can be relaxed by putting them into hot water.

Boxes for the permanent preservation of insects may be 17 or 18 inches square, two and a half inches deep, outside measurement, and one inch and a half or a trifle more in the clear, made of perfectly seasoned wood, halved together in the middle, so as to have an upper and lower part, the former serving as the cover. The lower part must be lined on the bottom with sheet cork or thin strips of corn-stalk, and the whole covered with soft white paper. The paste with which the paper is attached should have a portion of arsenic stirred in with it, to guard against destructive vermin. The upper part, or cover, should be cut in around the top, like a window sash, so as to receive a plate of glass, which is to be secured in the usual way with putty.

Every insect drawer should have a lump of gum camphor rolled in a piece of muslin and pinned into one corner, to keep out destructive vermin. The presence of vermin is detected by little heaps of the dust-like gnawings under the infested specimens. Such specimens should be at once removed, and if the drawer is much infested, a teaspoonful or two of benzine should be poured upon the bottom, and the drawer or box immediately closed, so as to retain the fumes.

MAGNIFYING GLASSES.

A magnifying glass consisting of one, or, what is better, two lenses, so arranged that they can be used either singly or combined, is absolutely indispensable in studying insects. This simple instrument, the

usual cost of which is one dollar per lens, is all that is usually required. It is a common mistake to suppose that insects cannot be studied and classified without the use of a complex and costly microscope. Such instruments are useful only to examine excessively minute or transparent objects, and though sometimes indispensable to the professional entomologist, they are rarely used in the ordinary study of insects.

THE INSTINCT OF INSECTS.

Instinct is that faculty by which animals are enabled to discover their food, construct their nests, and provide for their young, and to perform these operations without having had any previous education or experience. Many of the manifestations of this faculty are truly wonderful and unaccountable. Such are the mathematically accurate construction of the cells of the honey-comb; the curious economy of the ants and bees; and the provisions which many kinds of insects make for the future subsistence of their young, even in advance of their existence.

Instinct is often spoken of as an imperfect or partially developed reason, but its relation to that faculty can be, at most, only that of a very remote analogy. It differs from reason in its invariableness and its almost absolute infallibility, but most essentially in its independency of previous knowledge and experience. Reason acts only by virtue of what is already known, and man, who vastly excells all other animals in his reasoning powers, approaches perfection in any complex work only by long study and practice; the honey-bee, on the contrary, constructs its first cell with such mathematical accuracy that it cannot be improved by any subsequent experience.

Some of the higher animals, such as the horse and the dog, give proof of the possession of a reasoning faculty similar to our own, and inferior only in degree. But whilst the manifestations of reason are fainter as we descend in the animal scale, instinct becomes more remarkable, and in insects especially, in which reason is almost if not absolutely wanting, instinct is exhibited in its highest perfection, far surpassing, in many instances, in accuracy and prescience, the reason of man himself.

Of the nature of the instinct of animals, as of that of the human mind, we know absolutely nothing; and we can only confess our ignorance by referring its wonderful manifestations to the direct agency of the Creator.

INSECTS FROM A PRACTICAL OR ECONOMIC POINT OF VIEW.

In regarding insects from this point of view, we have to consider them in both their beneficial and their injurious relations. The directly beneficial insects are almost limited to the three well-known species: the honey-bee, the silk-worm and the cochineal-insect; whereas, those

species which are injurious to mankind, chiefly by depredating upon valuable cultivated crops, are much more numerous, although constituting but a very small proportion of the whole insect world. It is important to bear in mind that in these destructive operations insects occupy an exceptional or abnormal position, and that we ourselves have been the means of bringing about this state of things, by the excessive cultivation of certain plants, whereby a corresponding increase of certain species of the insects which feed upon them has been induced. It is very rarely that any such loss of balance between the insect and the vegetable worlds takes place in the state of nature; and yet, such occurrences are not wholly unknown. This has happened most remarkably in the case of wood-eating insects, there being instances on record in which extensive tracts of forest trees have been destroyed by the larvæ of some of the more minute wood-boring beetles.

But, as just stated, it is in their depredations upon some one or other of the more valuable cultivated crops that insects have come into the most direct and serious conflict with human interest. These depredations, as is well known, have often been of a most extensive and ruinous character, causing the annual loss of crops to the value of many millions of dollars, and in some seasons and localities, necessitating the total abandonment of some of the most valuable and staple productions, such as wheat, barley and potatoes, and also some of our choicest fruits, such as the plum and the peach; and sometimes threatening the destruction even of the most valuable fruit of all—the hardy and widely distributed apple. These destructive operations of insects have necessarily attracted to them the most earnest attention of both practical and scientific men, and many valuable treatises and reports have been written which have been devoted chiefly to the practical treatment of the subject. It is our present intention to treat of insects from a more general and comprehensive point of view.

GENERAL UTILITY OF INSECTS.

From what has just been said, it is evident that it is in the nature of their food and their food-taking habits, that insects hold the closest relationship to human interests; and this is true not only in the direct manner above described, but also indirectly, by means of the important parts which they fulfill in the economy of nature. Indeed, the operations of insects in this last respect are of such vast importance, that it would be safe to say that if these should cease, the earth would soon become uninhabitable by mankind. These operations consist chiefly, first, in the destruction of other insects by the predaceous and parasitic kinds, whereby the excessive increase of the former is held in check; secondly,

in the instrumentality of a large proportion of insects in their character of scavengers, whereby the decomposition of decayed and offensive matters, both animal and vegetable, is effected and accelerated; and thirdly, in the agency of insects in causing the fertilization of plants, especially those with very deep corrollas, and those which have the barren and productive flowers upon different plants, by carrying upon their legs, in their search for honey, the fertilizing pollen from one flower to another. A long chapter might be written upon each of these topics, but we have space here barely to enumerate them.

DIVISION OF INSECTS ACCORDING TO THE NATURE OF THEIR FOOD.

From this point of view all insects may be divided into two classes—the carnivorous insects, or those which eat animal food, (*Sarcophaga*); and the herbivorous insects, or those which subsist upon vegetable substances, (*Phytophaga*). Each of these classes is again divisible accordingly as the insects which compose it take their food in a fresh and living state, or in a state of decay. The former are called predaceous insects (*Adephaga*), when they live upon animal prey; and the latter are designated by the name of scavengers (*Rypophaga*). Those insects which eat living animal food, are still further divisible into predaceous insects proper, which seize and devour their prey, and parasite insects, which live within the bodies of their victims and feed upon their substance.

Those insects which feed upon decaying animal matter present three divisions: first, general scavengers, which devour particles of putrescent matter wherever they may be found; second, those which live exclusively in or upon the bodies of dead animals, (*Necrophaga*); and thirdly, those which are found exclusively in animal excrement, (*Coprophaga*).

The herbivorous insects may be divided in a similar manner into those which eat fresh vegetable food, (*Thalerophaga*), and those which subsist upon vegetable matters in a state of decay, (*Saprophaga*). They can also be usefully classified according to the particular parts of the plant which they devour, into lignivorous or wood-eating insects, (*Xylophaga*); the folivorous, or leaf-eating insects, (*Phyllophaga*); and the fructivorous, or fruit-eating insects, (*Carpophaga*).

The above Greek terms in parenthesis have been used chiefly in connection with the insects of the Coleopterous order, in which these diversities of food-habits exist to a much greater extent than in any of the other orders, but the terms themselves are of general signification, and being very concise and comprehensive, they might, not improperly, be used in speaking of insects in all the orders, so far as they are applicable.

DIFFERENCE OF FOOD OF THE LARVA AND THE PERFECT INSECT.

In attempting to classify insects according to the nature of their food we meet with a peculiar difficulty, owing to the remarkable change which some species undergo in this respect, in passing from the larva to the perfect state. Most caterpillars, for example, feed upon leaves, whilst the butterflies and moths which they produce subsist upon the honey of flowers, or other liquid substances. Some two-winged flies (*Asilidæ*) feed upon the roots of plants in their larva state, but become eminently predaceous in their winged state. Another remarkable example is furnished by certain coleopterous insects (*Meloidæ*), which are parasitic in their larva state, but subsist upon foliage after they have assumed the beetle form. The question therefore arises, to which stage of the insect's existence shall the precedence be given in this respect? At first view it would seem that the perfect state ought to govern, but when we take into account that insects are comparatively short lived in this state; that having arrived at maturity they require but little food; and that some insects take no food at all at this stage of their lives; whereas all the growth of an insect takes place whilst it is in the larva state, and consequently it is in this state that they feed so voraciously: when we consider this, it seems more reasonable that in classifying insects upon this basis, the food-habits of the larva should take the precedence.

In the following work I have not thought it best to adopt any inflexible rule in this matter, but have been governed by one or the other view accordingly as its importance might seem to preponderate in each particular case.

DISTINCTION BETWEEN NOXIOUS AND INJURIOUS INSECTS.

The terms noxious and injurious are often used indiscriminately, but strictly speaking, noxious insects are those which are endowed with some poisonous or otherwise hurtful quality; and these are divisible into two classes accordingly as they are hurtful to mankind directly, such as the mosquito, flea, and bed-bug; or are hurtful to the domesticated animals, as the horse-fly, the bot-fly, and the various kinds of animal lice. The insects which attack man directly are annoying rather than seriously hurtful, and this is usually the case also with those which molest the domesticated animals; but these sometimes multiply so as to seriously impoverish the animals which they infest.

The term *injurious*, as distinguished from *noxious*, is properly applied to all those insects which damage mankind indirectly, but often to a most serious extent, by depredating upon those crops upon which we depend for subsistence and profit.

NUMBER MORE IMPORTANT THAN SIZE.

It is worthy of remark that by far the greater proportion of the damage caused by injurious insects is effected by species of very small size, whilst the large species are generally harmless. The two most serious fruit insects, the Codling-moth and the Plum-curculio, are both below the medium size, and the Apple bark-louse, the Apple-aphis, the Hessian-fly, and the Wheat-midge, are so minute that they would not be noticeable were it not for the wide destruction which they cause to some of our most valuable crops, in consequence of their excessive multiplication.

TREATMENT OF INJURIOUS INSECTS.

For the details of treatment the reader is referred to the practical treatises and reports which have been published upon this subject. We can give here only an abstract of the methods to be pursued.

First, hand-picking and destruction by machinery, as in the case of the Colorado potato-beetle; second, poisoning by such substances as Paris-green, hellebore, and carbolic acid, as in the cases of the Potato-beetle, and the Currant saw-fly; third, rendering their food distasteful and repugnant to them by the application of such substances as ashes, lime, and whale-oil soap, which are applicable to all foliage-eating insects; fourth, anticipating their attacks by planting at such times as will cause the crops to sprout or to mature too early or too late for them, both of which plans are exemplified by winter wheat, in its relation to the Chinch-bug and the Hessian-fly; and fifth, when all other means fail, preventing their ravages by abstaining for a year or two from raising the damaged crops. To these may be added, in certain favorable instances, the transportation and colonization of friendly parasites. An experiment of this kind has been performed by the author by the transportation from the central to the northern parts of the State of Illinois, of the minute Chalcis-fly, which is parasitic upon the Oyster-shell Bark-louse.

The above list exhibits the most common methods of contending with injurious insects, and these methods admit of almost indefinite modification. But they can be most usefully described in connection with the particular species of insect to which they are respectively applicable.

USE OF LEARNED AND SCIENTIFIC TERMS.

With regard to the use of scientific terms, derived mostly from the Greek and Latin languages, it is to be remarked that though they may appear difficult and forbidding, at first sight, the student soon becomes familiarized with them, and finds them to be almost indispensable by enabling him often to express in one or two words what would require a

whole sentence in English. It is also an important consideration that in learning the elements of any science or art, an indispensable part of such education is to acquire a knowledge of the more common technical terms which properly belong to it, and which constitute its peculiar phraseology, and which the student will continually meet with in all writings upon the subject. In a work intended, like the present, for the common student, all unnecessary use of such words should, of course, be avoided, and whenever we have found it necessary to use them, we have taken care, as a general rule, to explain their meaning, either directly or by the nature of the context.

The student must not expect that any science can be so simplified as to remove all difficulties; and especially true is this of so extensive and complex a science as entomology. Nor is it desirable that this should be done. One of the principal advantages to be expected from the study of this science is the admirable mental discipline which it affords. The forms with which it has to deal are so numerous and diversified, and often, at the same time, so closely allied, that their classification constantly demands a minute and careful examination, and a discriminative analysis, which, regarded purely as an exercise of the mind, are scarcely inferior to those required by the abstract mathematics, whilst they possess the additional interest which naturally attaches to the study of living beings.

CLASSIFICATION AND NOMENCLATURE.

Classification in natural history has two objects in view—first, to show the relationship which exists between organized beings, by putting them in groups in accordance with the similarity of their characters; and secondly, to facilitate the study of them by enabling the student to comprehend a great number of different but allied forms under a comparatively small number of general heads, and thus to afford an important aid to the memory.

By nomenclature is meant the giving to these groups and the species which compose them distinctive names. This is necessary to enable us either to receive or to communicate knowledge; and without it natural history could not be raised to the dignity of a science.

In a department so extensive as that of insects a very great number of names, not only of species, but of the groups in which these are comprehended, must be necessarily introduced. It is therefore important that the science shall not be encumbered by the creation of unnecessary genera, or such as are founded upon slight and unimportant characters. It is, indeed, often difficult to determine precisely what characters or combination of characters necessitate or justify the formation of a new genus, or the subdivision of an old one. No definition of the term *genus* which is universally applicable ever has been, or perhaps

ever can be given, inasmuch as the characters which constitute it often possess very different values in the different genera and families, not only of insects, but of animals generally, and therefore the formation of genera must necessarily be left to the judgment of the author.

It is the natural tendency of the specialist to attach undue value to the minor subdivisions of his particular department, whilst he whose studies take a wider range sees more forcibly the necessity of condensation and simplification. Much can be said upon both sides of this question, but perhaps the argument may be condensed into a single sentence by saying that, on the one hand, the minute subdivision of a natural group tends to give definiteness and precision to our investigations, whilst, on the other hand, the multiplication of genera or sub-genera, upon trivial characters, unnecessarily encumbers our nomenclature, and diminishes the interest and importance which ought to attach to the generic distinction.

In writing the names of insects—and the same rule applies to all other departments of natural history—it is the established custom to write first the name of the genus, usually without the author's name attached, and immediately following it the specific name, with the name of the original describer, or an abbreviation of it, appended. As no one can carry all the modern genera of insects in his memory, it is an excellent practice, when space permits, to prefix the name of the older and more comprehensive genus to which such species was formerly referred, and with which most entomologists may be presumed to be familiar. In this case the modern genus is included in a parenthesis, and usually with the author's name attached.

To illustrate by examples: The common rose-slug is the larva of a little wasp-like insect, known scientifically as the *Selandria rosæ* of Harris. This species was first described by Dr. Harris, who gave to it the specific name *rosæ*, meaning *of the rose.* It belongs to the modern genus *Selandria*, which was founded by Dr. Leach, an English entomologist. This genus is a subdivision of the old genus *Tenthredo*, of Linnæus. The name written in full, therefore, will stand:

Tenthredo (Selandria, Leach*) rosæ*, Harris.

Our fine large Polyphemus moth was originally described by Linnæus under the name of *Attacus Polyphemus.* It belongs to the modern genus Telea, made by the German lepidopterist, Hübner. Its name, therefore, expressed in the simplest manner, is *Telea Polyphemus*, Linn.; or written in full—

Attacus (Telea, Hübner*) Polyphemus*, Linnæus.

This is ordinarily all that is essential to be known, and any additional synonyms or references should be placed in a subordinate position.

It will be observed that all the family names of insects end in *idæ*. This is a Greek termination, meaning *like* or *similar*, and implies that all the species in any such group have a family resemblance to those of the leading genus to which it is affixed—thus: *Cicindelidæ* means *Cicindela-like* insects. In pronouncing these words the accent is placed upon the syllable preceding this termination, thus: *Cicindel-idæ*, *Carab-idæ*, etc.

It is often the case that families, especially those which contain many species, admit of division into a number of natural groups of a higher rank than genera, which are designated as sub-families, and distinguished by the termination *ides*. Thus the family Caribidæ is divided into a number of sub-families, such as the *Brachinides*, the *Scaritides*, etc.

DIVISION OF INSECTS INTO ORDERS.

The class of insects is divided into a number of primary groups called *orders*. Between these larger divisions are certain smaller ones, which serve as connecting links between them, and which some authors have merged in one or the other of the adjoining larger groups, whilst others have considered them of sufficient importance to be raised to the same rank with the larger ones. From this it has resulted that the number of orders into which the class of insects has been divided has varied, even in the works of standard authors, from seven to twelve, and the number will be still increased if we regard as distinct orders certain apterous form, such as the lice *(Pediculi,)* and the springtails *(Thysanura.)*

But as in this elementary treatise it is the intention to simplify the classification of insects as much as possible, we have adopted the smaller number of orders, with the single exception of recognizing the division of the Hemiptera into Homoptera and Heteroptera as of ordinal value.

The orders of insects are founded primarily upon the number and structure of the wings. This mode of division was first suggested by Aristotle, who gave the names which they now bear to two of the orders, namely, the Coleoptera and the Diptera. It was afterwards almost perfected by Linnæus, but has been somewhat modified by more recent authors.

The orders, at the present time, are usually arranged in two sections, with four orders in each, based upon the form and structure of the mouth.

TABLE OF THE ORDERS OF INSECTS.

Section 1st. *Mandibulata*, or *Gnawing Insects.*—Mouth composed of jaws and mandibles.

A. Upper wings of a horny or leathery consistency; under wings membraneous.

B. Upper wings horny, and usually inflexible; under wings folded both lengthwise and crosswise; inactive in the pupa state: COLEOPTERA.

B B. Upper wings coriaceous, or like parchment; under wings folded lengthwise only; active in all their stages: ORTHOPTERA.

A A. All four wings membraneous and transparent.

C. Wings with many branching veins, and usually many cross-veins; abdomen without an ovipositor....NEUROPTERA.

C C. Wings with comparatively few veins; abdomen of the females terminating in an ovipositor or a sting: HYMENOPTERA.

Section 2d. *Haustellata*, or *Sucking Insects.*—The mouth consolidated into a proboscis or sucker.

A. Wings four.

B. Wings covered with bran-like scales...........LEPIDOPTERA.

B B. Wings naked.

C. Upper wings of the same texture throughout, not lapping over each other, deflexed or roof-shaped when at rest: HOMOPTERA.

C C. Upper wings coriaceous at base, membraneous at tip, lapping one over the other at the tip, and lying flat upon the abdomen when at rest.............HETEROPTERA.

A A. Wings two, membraneous.........................DIPTERA.

Order of COLEOPTERA.

The Coleoptera, (a term composed of two Greek words, *χολεος a sheath*, and *πτερα wings*,) commonly called *beetles*, are the most numerous division of the mandibulate or gnawing insects. They are distinguished from all other insects by the hard texture of their bodies, and by their horny wing-covers, called *elytra*, which represent the upper pair of wings of other insects. The elytra are not moved in flight, but only raised so as to permit the free motion of the lower or true wings, and a few of the chafers *(Cetoniæ)* do not even raise them during flight. They are generally hard, horny and inflexible, but in the lightning-beetles *(Lampyridæ)* and a few others, they are comparatively thin and flexible, but never membraneous like the lower wings. The inferior or true wings differ from those of almost all other insects in being folded crosswise, as well as lengthwise, when at rest under their cases. The Buprestidæ and a few others form exceptions to this rule. A few kinds which live under stones and in other dark places, and which have no occasion to fly, have no wings under their elytra.

Owing to the perfect development and the hard texture of the crust or integument of the Coleoptera, and also to the circumstance that it is not usually much obscured by hair, this part is made more use of in classification than it is in any of the other orders. The upper side exhibits the three divisions of the insect's body: the head, the thorax, and the abdomen, covered by the elytra. Between the elytra, at their base, or where they join the thorax, is almost always a small triangular piece called the *scutellum*. On the under side, each of the principal parts is seen to be composed of a considerable number of pieces usually soldered together, and distinguished only by fine impressed lines called *sutures*. These subdivisions and their names will be sufficiently understood, without the necessity of a detailed description, by the annexed figure of one of the ground-beetles *(Harpalus caliginosus)* and the accompanying explanation, taken in connection with the general description in the beginning of the work.

EXPLANATION OF THE FOLLOWING FIGURE.

The oblong narrow piece in the middle of the mouth, marked L, is the *ligula* or tongue. At the extremity of the ligula are two little wings or side pieces marked *p p*; these are the *paraglossæ*. The other parts of the mouth are named in the figure, and have been described in the introductory part of this work. The under side of the head, behind the mentum or chin, is called the *gula* or *throat*.

The under side of the thorax is divided into a considerable number of pieces more or less distinct, and separated from each other by impressed lines called *sutures*. The middle portion is called the *sternum*

[Fig. 3.]

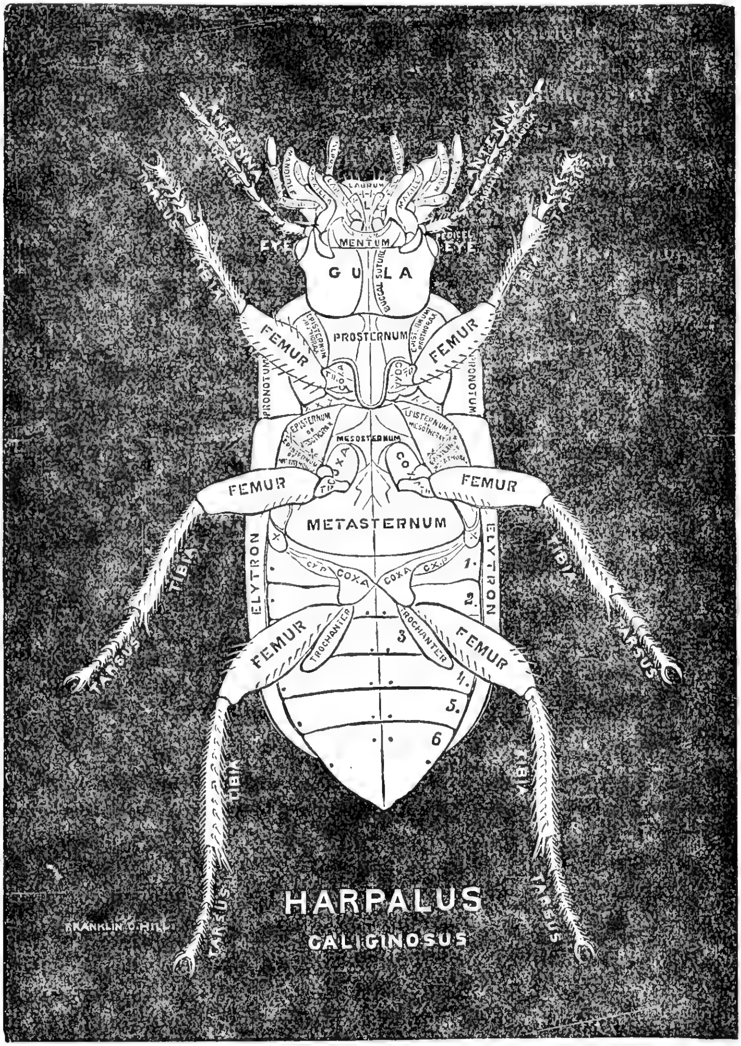


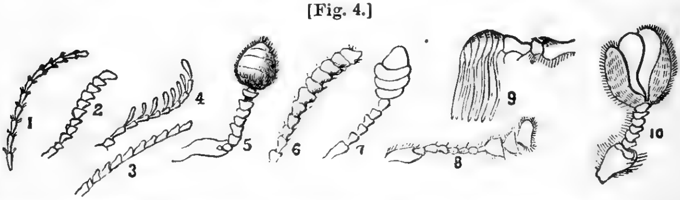
Diagram illustrating the structural parts of a beetle.

or breast-plate, and is divided into three parts, the *prosternum* or fore breast-plate; the *mesosternum* or middle breast-plate; and the *metasternum* or hind breast-plate. Each of these parts has a side piece, called the *episternum;* so that there is an episternum of the prothorax; an episternum of the mesothorax; and an episternum of the metathorax; all of which are labeled in the figure. Directly behind each episternum is a smaller piece called the *epimeron.* These are indicated in the figure by stars; three stars marking the epimeron of the prothorax; two stars the epimeron of the mesothorax; and one star the epimeron of the meta-

thorax. The epimeron of the mesothorax is very narrow in Harpalus, and scarcely distinguishable without the aid of a lens; but in a part of the long-horned beetles (*Saperda*, etc.) and in some others, it is considerably wider, and affords valuable characters in classification. The *trochanters*, or little joints at the base of the thighs, are marked T R in the figure, except the large hind trochanters, where the name is printed in full. Behind the metasternum, and extending outwardly from the hind coxæ is a narrow piece marked CX. P. This is the *hind coxal plate.* This is a very narrow piece in Harpalus, but in some of the serricorn beetles (*Buprestidæ* and *Elateridæ*), it is much wider, and furnishes important generic characters, and in Haliplus, a genus of water beetles, it is excessively dilated. The other parts are sufficiently named in the figure.

The *antennæ* of the Coleoptera are usually eleven jointed and of moderate length, but they are subject to much variation both in length and form, as will appear in the descriptions of the different families. The subjoined figures show their most common variations, and the names by which they are designated. These forms have been more particularly described on a former page, when treating of insects in general.

[Fig. 4.]



ANTENNÆ OF COLEOPTERA.—1, filiform or thread-shaped; 2 and 3, serrate or saw-toothed; 4, pectinate or comb-toothed; 5, capitate or knobbed; 6, 7, 8, clavate or club-shaped; 9 and 10, lamellate or plated. —after LECONTE.

The *palpi*, or little jointed appendages to the mouth, also sometimes furnish important characters in classification. They vary chiefly in the shape of the terminal joint, which is sometimes much narrower than the others, when it is called *acicular* or needle-shaped, and sometimes much widened, so as to be in the form of a triangle or of a half-moon, or hatchet.

As the terms *large*, *small* and *medium-sized* are often used in speaking of insects, and as these words vary considerably in force, when used in different relations, we give below their average meaning when applied to the Coleoptera:

An inch or more in length, - - - - -	Very large.
Three-quarters of an inch, - - - - - -	Large.
Half an inch, - - - - - - - - -	Medium.
Quarter of an inch, - - - - - - -	Small.
One-eighth of an inch or less, - - - - -	Very small.

The intermediate sizes are expressed by such phrases as *rather large*, *rather small*, or *a little above*, or *a little below the medium*, etc. This

standard applies only when speaking of any one group of beetles as compared with the Coleoptera generally. The same expressions will necessarily vary in force when applied to the species of a particular group as compared with each other, accordingly as the species of that group are large or small as compared with the rest of the order; that is to say, a small species of a group of generally large-sized insects may be larger than a large species of a small-sized group.

LARVÆ AND PUPÆ.

The *larvæ* of the Coleoptera are usually soft whitish grubs; naked, or with a few scattered hairs; with a mandibulate mouth not very unlike that of the perfect insects; usually furnished with six short feet and a single terminal proleg, but sometimes wholly footless. They live in secluded situations, sometimes in the ground, but oftener in the wood or under the bark of decaying trees, or in putrescent animal substances, and not unfrequently in nuts and seeds, and in the pulp of fruits. They are rarely found exposed to the light of day, and therefore they never exhibit the beauty of coloration, nor the variety of clothing which gives so much interest to the study of the caterpillars, which are the larvæ of the moths and butterflies. The larvæ of most of the families of Coleoptera are now pretty well known, but owing to the circumstances just mentioned, they have generally received but little attention from entomologists compared with that which has been bestowed upon the perfect insects. The larvæ of the several families will be more particularly described in their proper connections.

The *pupæ* are rarely inclosed in cocoons, but the larvæ, before changing, simply form cells by turning themselves round and round in the earth or rotten wood, in which they usually undergo their metamorphoses. But some larvæ, especially in the families of Curculionidæ and Chrysomelidæ, construct regular cocoons of web, not very unlike those of the nocturnal Lepidoptera, which they attach to the plants upon which they feed. The legs of the pupæ are always free, but they are not used, the insects being dormant and motionless during this stage of their existence.

THE COLEOPTERA FROM A PRACTICAL POINT OF VIEW.

In order to show more clearly the connection between scientific and practical entomology, in classifying the Coleoptera we have taken the food-habits of the several species as the basis of classification, it being in the nature of their food, and their methods of obtaining it, that insects come into the most important relationship to mankind, whether of an injurious or a beneficial character. We refer to the Coleoptera particularly, because they exhibit a much greater diversity of food-

habits than any of the other orders of insects. Indeed this principle of classification is of value just in proportion as such diversity exists; and where it is very limited, as especially in the great order of Lepidoptera, it ceases to be available. Even in classifying the Coleoptera upon this basis, and at the same time paying the necessary respect to structural considerations, we are sometimes compelled to place insects of similar food-habits in several different, and sometimes remote, tribes. The wood-boring beetles, for example, constitute three distinct tribes, designated as the saw-horned borers *(Buprestidæ)*; the long-horned borers *(Cerambycidæ)*, and the short-horned borers *(Scolytidæ.)* There are likewise four distinct families of fungus-beetles, found respectively in each of the four tarsal sections. But notwithstanding such instances as these, the Coleoptera admit of a very interesting, useful, and, in the main, natural classification in accordance with the nature of their food.

As compared with the other orders of insects the Coleoptera are surpassed only by the Lepidoptera in the extent of their injuries to cultivated crops; and indeed they are so nearly equal to the latter in this respect, that there may be a doubt which takes the precedence; and it is true of either of these two orders, that, with the exception of the other, it includes a greater number of injurious species than all the other orders of insects combined. The great destructiveness of the Lepidoptera is readily explained by the nature of their food, nearly all their larvæ, commonly known as caterpillars, subsisting upon plant-food, and mostly in a fresh and growing state. The Coleoptera, on the contrary, embrace, in addition to the plant-eating species, extensive tribes of predacious and scavenger beetles, which are indirectly of incalculable benefit to mankind.

In studying the bearing of scientific upon practical entomology, nothing perhaps is more important than to trace the connection of the external structure of insects with their habits, and especially with the nature of their food; since we are thus enabled, to a certain extent, to determine the habits of an insect by simply observing the form and structure of its visible parts. We are able to lay down some general rules of this kind with respect to the Coleoptera, though most of them are subject to important exceptions. In order not to give too much space to this part of the subject, we will limit our observations to two of the most important and prominent organs—the antennæ, and the feet, or tarsi.

All predaceous beetles have filiform antennæ except the lady-birds or Coccinellidæ.

All the scavenger beetles have strongly clavate or knobbed antennæ, except the short-winged scavengers or Staphylinidæ, and these are only partial exceptions, as many of them are known to be predaceous.

All the leaf-eating beetles have filiform or nearly filiform antennæ, except the herbivorous Lamellicorns (*Rutelidæ* and *Melolonthidæ.*)

All fungus-eating beetles have the antennæ more or less strongly clavate.

The feet of the Coleoptera are of two principal kinds; first, *simple feet*, in which the joints are slender, and of about the same width throughout, and clothed only with somewhat scattered bristles; and secondly *bi-lobed feet*, in which the joints are somewhat widened and depressed, with the last joint but one usually a little wider than the others, and divided into two lobes, between which the last joint is inserted, and all of them clothed beneath with densely crowded short stiff hairs, of the same length, so as to resemble a brush; sometimes also compared to a piece of sponge.

As a general rule, beetles with simple feet reside upon the ground, or under the bark of dead trees, or in other decomposing matter, and are either carnivorous or rypophagous (filth eating) in their habits; and those which have bi-lobed and spongy feet live upon the foliage of trees and other plants, this structure of the feet seeming to be especially adapted to enabling them to adhere to the surface of leaves; and accordingly most of these insects are herbivorous.

But this general statement is subject to important exceptions. Some of the lamellicorn beetles (*Melolonthidæ*, *Rutelidæ*, etc.) have simple feet and yet feed upon the foliage of trees; but these insects do not run over the leaves, but simply cling to them with their sharp claws, whilst feeding.

So, also, some carnivorous beetles (*Telephoridæ* and *Coccinellidæ*), which pursue their prey over the foliage of trees, have their feet bi-lobed and spongy.

It is an interesting circumstance that those insects (*Melolonthidæ*, etc.) which only cling to the foliage by their claws, do not breed upon the trees, but pass their larval period under ground, subsisting upon roots or other subterranean matters, and only visit the trees for the sake of feeding; whereas the true Phytophaga, with spongy feet (*Chrysomelidæ* and their allies) live upon the plants upon which they feed, through all the active stages of their existence.

It is also a curious coincidence that the insects first mentioned, which only visit the trees occasionally for the purpose of feeding, do so only by night; whilst the genuine Phytophaga (plant eaters) are diurnal in their habits.

There is another partial but important exception to the rule above laid down, as respects the males of many carnivorous beetles, which have some of the joints of their anterior feet much widened and brushed underneath; but here the last joint but one is not bi-lobed, and the brush

is usually confined to the anterior pair of feet, rarely extending to the middle pair, and never to the hind ones; besides being limited exclusively to the males.

Whilst some of the other orders of insects excel the Coleoptera in the perfection of their instincts, no other order can be compared with them in the diversity of their food, and their corresponding habits and organization. Indeed the Coleoptera combine, to a great extent, the food-habits of all the other orders. The herbivorous habits of the Orthoptera, the carnivorous habits of the Hemiptera, the aquatic habits of the Neuroptera, the honey-eating and the parasitic habits of the Hymenoptera, the leaf-eating habits of the larvæ of the Lepidoptera, and the putrivorous habits of the Diptera—all find their parallel in the ranks of the omnivorous Coleoptera.

CLASSIFICATION OF THE COLEOPTERA.

The Coleoptera are usually divided into four sections founded upon the number of joints in their tarsi, or feet.

These sections may be tabulated as follows:

Sec. 1.	Five joints in all the tarsi	*Pentamera.*
Sec. 2.	Five joints in the anterior and middle tarsi, and four joints in the hind tarsi	*Heteromera.*
Sec. 3.	Four joints in all the tarsi	*Tetramera.*
Sec. 4.	Three joints in all the tarsi	*Trimera.*

These terms, except the second, are composed of the Greek numerals meaning respectively, *five*, *four*, and *three*, prefixed to a word meaning *parts* or *pieces*. The prefix *hetero*, in the seeond section, means *different.*

As a general rule insects have five joints in their tarsi, and never more than five. This may, therefore, be regarded as the normal or typical number, and a smaller number must be taken as an indication of inferiority or degradation, using this word in its scientific sense. In accordance with this view, the most perfect and highly organized beetles are found in the pentamerous section; and in those which have less than five joints, there is usually a little swelling at the base of the last joint, which is supposed to be a vestige of the missing joint. This circumstance has led some authors to give more complex names to these sections, expressive of this character, but with the explanation here given we have preferred to retain the simpler nomenclature of Geoffroy and Latreille.

SUGGESTIONS TO AID IN CLASSIFYING THE COLEOPTERA.

The student will perceive that the primary division of Coleopterous insects is based upon the number of joints in their feet, or tarsi. This character, though apparently of trivial importance, is found to furnish an index to a more natural classification than can be established upon

any other single character. In almost all beetles of considerable size, that is, more than a quarter of an inch in length, this character is very uniform, or, in other words, the number of tarsal joints in the insects of any one section or family, is remarkably unexceptional. It also has the advantage, in insects of this size, of being easily determined, if not by the naked eye, at least by the aid of a simple lens.

But the insects which are necessarily the most difficult to examine and classify are the very small ones, and here the character founded upon the number of tarsal joints not only becomes more difficult to determine, but more exceptional, and therefore of less value. We therefore give the following suggestions to aid the inexperienced student in cases of this kind.

The principal difficulty occurs with respect to numerous families containing very small species in the first or pentamerous section; and these are mostly limited to what are known as scavenger beetles, both the club-horned tribe, *(Clavicornes,)* and the short-winged tribe, *(Brachelytra.)* In the minute species of both of these tribes the number of tarsal joints is very irregular, one of them being often indistinct or wanting, especially in the posterior feet; and in three families at least, the Lathridiidæ, Trichopterygidæ and Pselaphidæ, two joints are wanting in all the feet, making them apparently but three-jointed.

The student will naturally inquire, why place these insects in the pentamerous section? The answer is, that they harmonize more closely with the insects of this section in their other characters, whilst they do not affiliate with the insects of the other sections which agree with them in the number of tarsal joints. An examination of their other characters will usually enable the student, after a little experience, to refer these insects to their true position; though cases sometimes occur which puzzle the most astute entomologist. They can hardly be confounded with the Heteromera, because these are, for the most part, much larger insects, and the exceptionally small species belong mostly to the tribe of Trachelides, which are distinguished from these and most other beetles by having the head attached to the thorax by a narrow neck. They differ from the Tetramera in the form of the tarsi and also that of the antennæ. Almost all these small species with deficient tarsal joints have these parts slender and simple, whilst all the genuine Tetramera have the tarsal joints somewhat widened and covered beneath with a dense brush of short hair, and the last joint but one is wider than the others, and divided into two lobes, between which the last joint is inserted. The only pentamerous beetles which have some of their tarsal joints obsolete, and at the same time have the last joint but one bilobed, are a part of the serricorn family of Cleridæ. Some of the short-winged scavengers (*Staphylinidæ*), with an irregular number of tarsal joints,

have a part of these joints widened but not bilobed in the males, but here it is a sexual distinction, and is confined to the anterior feet.

These small Pentamera, with variable tarsi, almost always have strongly clavate antennæ, except the Staphylinidæ, and these are distinguished at once by their short wing-covers. The true Tetramera, on the contrary, have the antennæ filiform, or at most slightly and gradually enlarged toward the tip, except the snout-beetles (*Curculionidæ*), and these are readily known by their elongated rostrum.

If, then, the student have in hand a small beetle whose place in the system he cannot determine with certainty, from the number of tarsal joints, let him first observe whether these joints are slender and simple or dilated and brush-like beneath, with the last joint but one deeply notched or bilobed; and then let him examine the antennæ, and observe whether they are slender and filiform, or whether they are decidedly enlarged at the end, either gradually (*clavate*), or abruptly (*capitate*).

1. *If the tarsi are simple and the antennæ filiform*, the species may belong to some one of a number of diverse families (*Carabidæ*, *Elateridæ*, *Mordellidæ*, *Melandryidæ*, *Cistelidæ*, and a few smaller families); but the beetles with this combination of characters are rarely of very small size, and they are, therefore, the more easily determined by their other characters.

2. *If the tarsi are simple and the antennæ clavate or capitate*, the insect may be referred, with very few exceptions, to some one of the families of scavenger beetles in the pentamerous section. This rule embraces a large proportion of very small-sized beetles, and will, therefore, be found of great use to the student in narrowing the field of his inquiry. A few apparent exceptions exist in the heteromerous families of Diaperidæ and Tenebrionidæ, but the former can be usually distinguished by their perfoliate antennæ, and the antennæ of the Tenebrionidæ are usually so slightly enlarged toward the tip as scarcely to be entitled to the name of clavate. Other partial exceptions are found in the family of Scolytidæ, or short horned wood-borers, all of which have strongly clavate antennæ, and some of which have simple tarsi; but many of them have the last joint but one slightly bilobed.

3. *If the tarsi are dilated and bilobed and the antennæ filiform*, the insect belongs to the family of long-horned borers (*Cerambycidæ*), or to that of the plant-beetles proper (*Chrysomelidæ*, etc.) The tarsi thus formed are almost always spongy on the under side. Only a few partial exceptions to this rule are found, and these are in the heteromerous families of Œdemeridæ, Anthicidæ, and a few others; but in these the tarsi are usually but slightly dilated, and but little, or not at all, spongy beneath.

4. *If the tarsi are dilated and bilobed and the antennæ clavate*, the species belongs to the tribe of snout-beetles (*Curculionidæ*), in the tetramerous section, or the family of Erotylidæ, or that of Coccinellidæ, in the trimerous section.

5. *Beetles with distinctly serrate antennæ* belong almost exclusively to the families of Serricornes proper, in the pentamerous section; but this rule also has a few exceptions. The pea and bean weevils (*Bruchidæ*), in the tetramerous section, usually have the antennæ decidedly serrate; and a few small families of the division of Trachelides, in the heteromerous section (*Rhipiphoridæ* and *Pyrochroidæ*), usually have the antennæ serrate in the females, and flabellate or branched in the males.

6. *All beetles with lamellate antennæ* belong to the division of Lamellicornes proper, in the pentamerous section. Only in very rare instances the branches of a pectinate or flabellate antennæ are somewhat flattened so as to resemble the true lamellate. An example of this is found in the little beetles of the genus Phlœotribus in the family of Scolytidæ.

Section 1. *PENTAMERA.*

Usually five joints in all the tarsi, one or two of them being sometimes deficient in very small species; all the joints usually slender and simple, except that the anterior, or anterior and middle tarsi are sometimes dilated and brush-like beneath, as a sexual distinction of the males.

It is seen by this formula that the pentamerous section is distinguished not only by the number, but also by the form and structure of the tarsal joints, the tarsi in this, and also in the succeeding or heteromerous section being, with but few exceptions, slender and simple, and clothed only with scattered hairs or bristles, whilst in the third and fourth sections the tarsi are widened and covered beneath with a dense brush of short hairs, or hair-like papillæ, and the penultimate, or last joint but one, is almost always bilobed. It is important to bear this two-fold distinction in mind, inasmuch as the form and structure of the tarsi often give the clue to the classification of small species in which the number of the joints is deficient or difficult to be determined. This has been already more fully explained in the general remarks on pages 30 to 34.

The ambiguity arising from the dilation of some of the tarsal joints in the males of certain species, can always be avoided by directing the examination to the hindermost tarsi, which are never so dilated.

This is the most numerous section, and comprises, as a general rule, the largest and most highly organized species in this order of insects, though it also contains many small species.

They can be divided into six sub-sections, founded upon their habits and the nature of their food, and distinguished primarily by the struc-

ture of their antennæ; and these sub-sections are again naturally divisible into a number of subordinate divisions or tribes. The following table gives a synopsis of the sub-sections, tribes, and families of the pentamerous beetles. The names given to these sub-sections are generally recognized, and in common use, except the first and the third. The term *filicornes*, though sufficiently characteristic of the predaceous beetles as compared with others of the pentamerous section, does not sharply distinguish them from some of the beetles of the other sections; and the term *monilicornes*, applied to the third sub-section—which is composed chiefly of the family of Staphylinidæ, though tolerably characteristic, especially of the larger and typical species—is not ordinarily applied to them, for the reason that the beetles of this division are more readily and strongly distinguished by another character, namely, the remarkable shortness of their wing-covers, expressed by the Greek term *brachelytra*, by which they are generally designated, or the corresponding Latin word *brevipennes*, which is sometimes, but less commonly used.

SYNOPSIS OF THE PENTAMEROUS COLEOPTERA.

SUB-SEC. I. *Filicornes.* Attennæ filiform. Habits predaceous.

Tribe 1. Predaceous ground beetles. (*Carnivora terrestria.*) GEODEPHAGA, MacLeay.

Families: Cicindelidæ; Carabidæ.

Tribe 2. Predaceous water beetles. (*Carnivora aquatica.*) HYDRADEPHAGA, MacLeay.

Families: Dytiscidæ; Gyrinidæ.

SUB-SEC. II. *Clavicornes.* Antennæ club-shaped. Habits mostly putrivorous.

Tribe 3. Water scavanger-beetles. (*Putrivora aquatica.*) PHILHYDRIDA, MacLeay.

Families: Parnidæ; Hydrophilidæ.

Tribe 4. Land scavenger-beetles. (*Putrivora terrestria.*) NECROPHAGA partly, Latreille.

Families: Silphidæ; Scaphidiidæ; Histeridæ; Nitudilidæ; Dermestidæ; Mycetophagidæ; Cryptophagidæ; Byrrhidæ; Anisotomidæ; Phalacridæ; Trichopterygidæ; Scydmenidæ; Trogositidæ; Cucujidæ; Colydiidæ; Lathridiidæ.

SUB-SEC. III. *Monilicornes.* Antennæ more or less moniliform or bead-like; wing covers very short. Habits mostly putrivorous.

Tribe 5. Short-winged scavengers. (*Putrivora brevipennata.*) BRACHELYTRA, Latreille.

Families: Staphylinidæ; Pselaphidæ.

SUB-SEC. IV. *Pectinicornes.* Antennæ pectinate or comb-toothed

Tribe 6. Stag beetles.

Family: Lucanidæ.

SUB-SEC. V. *Lamellicornes.* Antennæ lamellate. Food-habits different in the two tribes.

Tribe 7. Lamellicorn dung-beetles. (*Excrementivora lamellicornia.*) SAPROPHAGA, MacLeay.

Families: Copridæ; Aphodiidæ; Geotrupidæ; Trogidæ.

Tribe 8. Lamellicorn leaf-beetles. (*Herbivora lamellicornia.*) THALEROPHAGA, MacLeay.

Families: Dynastidæ; Rutelidæ; Melolonthidæ; Cetoniidæ.

SUB-SEC. VI. *Serricornes.* Antennæ usually more or less serrate or saw-toothed. Food-habits various.

Tribe 9. Saw-horned wood-beetles. (*Lignivora serricornia.*) STERNOXI, Latreille.

Families: Buprestidæ; Elateridæ; Cebrionidæ.

Tribe 10. Aberrant wood-beetles. (*Lignivora aberrantia.*)

Families: Ptinidæ; Cupesidæ; Lymexylonidæ.

Tribe 11. Soft-winged predaceous beetles. (*Carnivora mollipennata.*) MALACODERMI, Latreille.

Families: Lampyridæ; Melyridæ; Cleridæ.

First Sub-section, FILICORNES.

Antennæ filiform; palpi apparently six; habits predaceous.

TRIBE I.

PREDACEOUS GROUND-BEETLES.

Carnivora terrestria. GEODEPHAGA,* MacLeay.

This extensive tribe of beetles is distinguished by their slender and filiform, or slightly tapering antennæ, in connection with their five-jointed tarsi or feet, all the joints always being distinct even in the smallest species; by having apparently six palpi; and by the prominence of their large egg-shaped posterior trochanters, which furnish a very distinctive and easily recognized character, and which no other coleopterous insects possess so conspicuously developed. (See Fig. 3, on page 27.) No insects have strictly more than four palpi, and the apparent additional pair which is peculiar to this and the following tribe, are really the outer lobes of the maxillæ which are here palpiform. They are almost exclusively carnivorous in their diet, and pre-eminently predaceous in their habits, both in the larva and the perfect states. They

* From the Greek γῆ the earth, and αδηφάγος ravenous.

subsist chiefly upon the larvæ of other insects, and are therefore useful in helping to maintain a proper balance of insect life. As their name implies, they are found mostly on the ground. They run with great rapidity, and never attempt to seek safety by feigning death, as is the habit with many of the leaf and fruit-eating beetles.

The tribe contains two families, distinguished as follows :

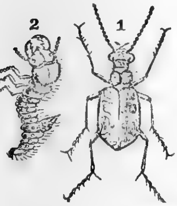
A. Head large and vertical, wider than the thorax ;* antennæ inserted on the front; eyes large and prominent; mandibles strongly toothed; wing covers usually marked with yellow : CICINDELIDÆ.

A A. Head horizontal or a little inclined, usually narrower than the thorax; antennæ inserted under the sides of the front; eyes moderate; mandibles simple or slightly toothed; color usually black; sometimes blue, green or brown; very rarely spotted : CARABIDÆ.

Family I. CICINDELIDÆ, (Tiger-beetles.)

The Cicindelidæ are readily distinguished from all other pentamerous beetles, by their large vertical heads; that is, their heads are so set upon the thorax that when viewed from above, only the vertex or crown is distinctly seen, the face looking directly forwards. In a few large species which vary from the family type the head is not quite vertical, but yet strongly inclined downwards.

[Fig. 5.]



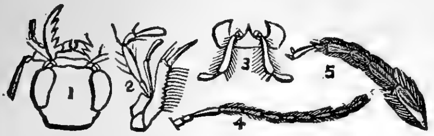
CICINDELA :—1, beetle; 2, larva—from Packard's *Guide*.

The common English name of Tiger-beetles expresses very well the character of these insects, and they may be said to represent in the insect tribes the tiger amongst quadrupeds, and the hawk and eagle amongst birds. They are the most highly organized and perfect of all coleopterous insects, and run and fly with equal facility. They are often seen running in hot dusty roads. When pursued they fly quickly, but usually alight again a rod or two in advance. About seventy species have been described as inhabiting the United States, including those found on the Pacific side of the continent.

* That part of the body of a beetle which, when viewed from above, lies between the head and the base of the elytra, commonly called the thorax, is found upon dissection to be only the anterior section or pro-thorax, which is here greatly developed; all of the meso-thorax, except the little triangular piece called the scutellum, and the whole of the meta-thorax, being concealed under the basal portion of the elytra. Many recent writers have, therefore, adopted for this part the name of *pro-thorax*, which thus has the advantage of greater anatomical precision. The term *thorax*, on the other hand, has the claim of brevity and of long established usage, and this brief explanation will relieve it of any ambiguity that might otherwise be attached to it.

Their larvæ dig holes in the sand, often a foot or more in depth, at the mouth of which they lie in wait for their prey, dragging it, when captured, to the bottom of their burrows. The name of the principal genus, *Cicindela*, is derived from the Latin, *Candela*, a candle or taper, and was applied by the ancients to the glow-worm. The species are all of medium or rather large size, and are generally marked with yellow angular spots upon a dark green or purple ground. The Cicindela sexguttata of Fabricius, of a brilliant metallic green color, with two yellow dots at the side, and one at the end of each wing-cover, is one of our most beautiful beetles. It is often seen running over prostrate logs in the forest, in search, no doubt, for wood-eating larvæ.

[Fig. 6.]



PARTS OF CICINDELA:—1, head; 2. maxilla; 3, mentum; 4, antenna; 5, anterior tersus—after LeConte.

Family II. CARABIDÆ, (Ground-beetles.)

The leading characters of this family have been given in the description of the tribe to which it belongs. They are readily distinguished from the Cicindelidæ by the position of the head, it being directed forwards instead of downwards, so that the face and parts of the mouth are fully seen when viewed from above. The two families, however, closely approach each other in some of their species.

[Fig. 7.]

MOUTH-PARTS OF CARABUS:—1, head; 2, maxilla; 3, mentum—after LeConte.

This is one of the most numerous families in the order of Coleoptera, eleven hundred distinct species having been already described as inhabiting North America alone. They are usually black, or of dark metallic colors, but are sometimes parti-colored. They are almost always found upon the ground, under stones, or in other obscure places. They never attempt to escape by flight, but run with great rapidity. Some of the smaller species, however, are seen flying in considerable numbers in the first warm days of spring, and a few are sometimes seen flying about our lights in summer evenings.

In view of the great numbers and predaceous habits of these insects, both in the larva and perfect states, it is evident that they must constitute a very important agency in holding in check the excessive multiplication of other insects. There are, however, a few exceptions to the almost universally carnivorous habits of this family. Species of the genera Omophron and Zabrus have been known to feed, even to an injurious extent, upon the soft grains of growing corn, and M. Zimmermann, in his memoir upon the genus Amara, states that the species

subsist mostly upon succulent roots, and upon the pith and stems of grasses.

The larvæ are active grubs, of an elongated form, with sharp, projecting mandibles, and usually furnished at the hind extremity with a pair of conical, bristly appendages. They live in the same obscure situations as the parent insects, but are still more retiring, and are seldom seen. They are very intolerant of confinement, and however well cared for, they rarely live long enough to complete their transformations.

The Carabidæ constitute a very difficult study, on account of their great numbers and the general uniformity of their coloring; and what adds much to this difficulty is, that some of the most valuable characters used in their classification are peculiar to the male sex, and therefore afford us no aid, if the specimen in hand happens to be a female. Nothing but the familiarity which is the result of long experience in the study of these insects, can enable the student to recognize the slight modifications of form by which the minor divisions are characterized.

Authors have differed much in the principal divisions which they have made in this family, accordingly as they have assumed one or another class of characters to be of primary importance. Linnæus united all the species which he knew in the single genus *Carabus.* Fabricius, and others of the earlier authors, established many new genera, and Latreille combined and systematized them in the *Genera Crustaceorum et Insectorum*, and subsequently in the *Regne Animal.* This author divides the Carabidæ into seven sections, based upon the forms of the elytra, feet and palpi. Lacordaire, in his great work upon the *Genera des Coleopteres*, following the method of Erichson, divides the family primarily into two legions, founded upon the peculiarities of the tibiæ and of the epimera of the metathorax; and these legions he subsequently divides into ten sections, corresponding, in the main, with the sections of Latreille, with three additional ones, to receive certain anomalous forms. Dr. J. L. LeConte, the learned Coleopterist of our own country, originally divided these insects, in his Notes upon the classification of the Carabidæ, published in the tenth volume of the Transactions of the American Philosophical Society, 1853, into three sub-families, founded upon the number of abdominal segments and the form of the epimera of the mesothorax. In his later work upon the classification of the Coleoptera of N. America, (1860,) he abandons the number of abdominal segments as of primary value, and divides the family into three sub-families, based upon the form of the epimera of the mesothorax, and the relative position of the intermediate coxæ.

Selecting from all these sources the characters which seem to be best adapted to our purpose, we will divide the Carabidæ into six sub-families, as follows:

A. Epimera of the mesothorax wide and reaching the middle coxæ; epimera of the metathorax indistinct.

B. Anterior tibiæ quite or almost without notch on their inner side, and never toothed on the outer side, both of their spurs at or near the extremity: CARABIDES.

B B. Anterior tibiæ with a notch on the inner side, near the end, and toothed on the outer side; one of the spurs at the end and the other above the notch; abdomen pedunculated; size extremely various; color black: SCARITIDES.

A A. Epimera of the mesothorax narrow, and not reaching the middle coxæ; epimera of the metathorax distinct; anterior tibiæ always notched, with one spur at the apex and the other above the notch; abdomen sessile.

C. Elytra truncated at the extremity, leaving the tip of the abdomen exposed; thorax more or less heart-shaped, and much narrower than the abdomen; tarsi not at all or but slightly dilated; claws often pectinate; color usually blue, green, or variegated, rarely brown or blackish, never pure black.......................................BRACHINIDES.

C C. Elytra entire, covering the whole of the abdomen; anterior tarsi of the males generally dilated; claws very rarely pectinate; colors various, mostly black.

D. Last joint of the palpi as wide, at least, as the others; size various, often small, but rarely very small.

E. Anterior tarsi of the males with the three first joints much widened, and covered beneath with a dense brush of hair-like papillæ; body often hairy or pubescent; colors usually green or blue-black, sometimes, but rarely, pure black ....CHLÆNIIDES.

E E. Anterior and frequently also the middle tarsi, with the four or three, or rarely two first joints dilated, and usually furnished beneath with two rows of scale-like papillæ, or more rarely with a brush of hairs; body usually smooth and shining; colors mostly black or metallic.................................HARPALIDES.

D D. Last joint of palpi very small; anterior tarsi of males usually with the first joint much dilated, and the second much less so, and scaly beneath; size small, usually very small.............BEMBIDIIDES.

The parts called *epimera*, made use of in the above table, will be understood by referring to Fig. 3, on page 27, where they are indicated by stars, as explained in the text. In section A, the epimeron of the mesothorax (indicated by two stars in the figure) is wide and somewhat triangular, and its inner extremity reaches the middle coxa, or rather forms a part of the wall or outline of the coxal cavity. But in section A A, (to which the species represented in the figure belongs) this epimeron is very narrow, and its inner extremity does not reach the coxal cavity, but impinges upon the anterior angle of the metasternum.*

It is not necessary, however, that the reader shall study out these parts. The several sub-families are sufficiently characterized without

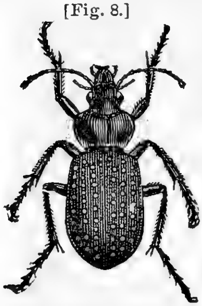
* This is best represented, but still imperfectly, on the right hand side of the figure. The inner extremity of the epimeron should have been represented as touching the metasternum, not at its apex, but a little behind it.

them. They are introduced here as probably indicating the natural relationship of the sub-families, and also because they form the basis of Dr. LeConte's classification of this family.

Sub-family CARABIDES.

This sub-family contains nearly all the large species in the family, the principal exception being the genus Pasimachus, in the family of Scaritides. These large species, constituting the Carabides proper, are distinguished from all the rest of the family by the absence of the characteristic notch on the inner side of the anterior tibiæ, near the extremity, and by having the two tibial spurs situated at the apex. All the other Carabidæ have a conspicuous notch in this part, and one of the spurs is inserted above the notch. The anterior tarsi of the males are usually dilated, and spongy beneath. The palpi terminate in a large triangular joint, and this sub-family was therefore called, by Latreille, *Grandipalpi*. This division of the sub-family embraces the genera Carabus, Calosoma and Cychrus. The *Calosoma calidum*, a large black beetle, an inch in length, with three rows of golden dots upon each wing-cover, is one of the most common of the larger Carabides. This is the species illustrated at figs. 8 and 9.

[Fig. 8.]



CALOSOMA CALIDUM:—Beetle—after Riley.

[Fig. 9.]

CALOSOMA CALIDUM:—Larva—after Riley.

But besides these large insects, a number of genera, composed of small and very different species, are usually included in this sub-family, in order to avoid a large number of primary divisions. This section contains the genera Elaphrus, Notiophilus and Omophron, all of which are usually found in wet situations. *Elaphrus ruscarius*, resembling a small Cicindela of an ashen bronze color, and with round pits upon the wing-covers, is often found in abundance running upon the wet sand along the margins of water-courses. Notiophilus is composed of small bronze-black species, not exceeding a quarter of an inch in length, and distinguished from the small species in the other sub-families by their large prominent eyes, giving to the head a width greater than that of the thorax. Omophron is an extremely anomalous genus, resembling a Coccinella or a Cassida much more than a Carabus. The species are rare in the northern States, but *Omophron labiatum* is common at the South, where its larvæ are said to depart from the ordinary carnivorous habits of the family, by feeding upon the grains of growing corn.

The most prominent characters of the leading N. A. genera are exhibited in the following table:

A. Body of the usual oblong form; meso-sternum and scutellum distinct.
  B. Thorax with a sharp lateral margin; tibiæ without notch; last joint of palpi large and triangular; eyes moderate, size usually large.
    C. Size large; elytra with numerous striæ.
      D. Head of ordinary form; epipleura narrow. *
        E. Third joint of the antennæ cylindrical; color mostly black.................CARABUS, 11.
        E E. Third joint of antennæ flattened; body with rich metallic tints........CALOSOMA, 21.
      D D. Head narrow; epipleuræ very wide..CYCHRUS, 25.
    C C. Size medium or below; elytral striæ not exceeding nine; color black...........NEBRIA, 18.
  B B. Thorax without a sharp lateral margin; tibiæ with a small notch and with one of the spurs at a distance from the apex; last joint of palpi moderate; eyes very large; size small.
    F. Thorax almost cylindrical, without salient margin, and much narrower than the abdomen; elytra with round shallow pits..............................ELAPHRUS, 10.
    F F. Thorax depressed with an obtuse margin, nearly as wide as abdomen; color bronze-black..NOTIOPHILUS, 8.
A A. Body almost orbicular; mesosternum covered by the prosternum; scutellum wanting; colors variegated..OMOPHRON, 9.

Sub-family SCARITIDES.

The most conspicuous character of this sub-family is the pedunculated abdomen, producing a separation between it and the thorax, whence this section was called *Bipartiti* by Latreille. But the most essential and unexceptional character is the form of the anterior tibæ, which are widened and flattened, and toothed on the outer side, and with the outer angle prolonged into a long point. This structure enables these insects to dig in the earth, a habit expressed by the name of the typical genus *Scarites* of Fabricius, meaning a *scratcher*. The sub-family is also remarkable for the extreme disparity in the size of its species, Pasimachus being usually an inch or more in length, and Dyschirius less than an eighth. The anterior tarsi of the males are very rarely, and then but slightly dilated.

[Fig. 10.]

SCARITES (ASPIDIGLOSSA) ANGULATA, Chaudoir–aft. Riley.

A. First joint of antennæ elongated. Size comparatively large.
  B. Thorax with the hind angles prominent. Size large, or very large. Elytra usually with a blue border ....PASIMACHUS, 14
  B B. Thorax rounded behind. Size medium, or above..............................SCARITES, 3
A A. First joint of antennæ moderate. Size small, or very small.
  C. Thorax somewhat square-shaped; abdomen elongate and depressed..............CLIVINA, 35
  C C. Thorax sub-globose; abdomen ovoid......................................DYSCHIRIUS, 38

Pasimachus is an exclusively North American genus. The *P. marginatus* of Bonelli, and the *P. elongatus*, LeConte, are common insects, usually found under stones or old logs. Dr. LeConte has given some interesting details of the habits of the larva of *P. elongatus*, which digs a deep hole in the ground, resting with its head at the entrance, and springing upon any prey that may come within its reach, thus resembling in its habits the larvæ of Cicindela.

* The *epipleura* is the margin of the wing-cover which is bent abruptly downwards, and covers the side of the abdomen.

Sub-family BRACHINIDES.

This sub-family corresponds to the section of *Truncatipennes* of Latreille. The elytra are cut off at the extremity, either straight across, or obliquely, leaving the tip of the abdomen exposed. One of the most conspicuous general characters is the marked difference in size, and often also in color, between the thorax and the abdomen, the thorax being usually scarcely wider than the head. The beautiful pectinate claws at the end of the tarsi, so common in this sub-family, are not found outside of it in any of our Carabidæ, except the genus *Calathus*, in the sub-family of Harpalides. Other characters have been given in the tabular view of sub-families. Most of the species are extremely active. Some are found under stones, but those with pectinate claws are often seen upon plants and flowers, this structure of their feet probably enabling them to adhere to the hairs or down, or other inequalities upon the surface of the foliage.

[Fig. 11.]

LEBIA GRANDIS, Hentz—after Riley.

The typical genus Brachinus (from the Greek *Βραχω, to resound*,) is remarkable for the faculty which the species have of discharging from the anus a pungent, volatile vapor, accompanied by an audible report, whence they have been denominated *bombardiers* by the French.

A. Antennæ filiform or setaceous. Abdomen more or less oval. Legs slender.
- B. Thorax more or less heart-shaped, as wide as the head, and with a sharp lateral margin.
  - C. Antennæ setaceous, first joint as long as second and third united; the second nearly as long as the third. Form oblong; size rather large; thorax reddish, and elytra blue or black.......GALERITA, 5 sp.
  - C C. Antennæ filiform, first joint moderate, second much shorter than the third.
    - D. Tarsal claws simple. Abdominal segments seven or eight. Color reddish yellow, with blue elytra.......BRACHINUS, 38
    - D D. Tarsal claws pectinate. Abdominal segments six. Colors various.
      - E. Palpi slender. Thorax sub-orbicular or sub-quadrate.
        - F. Thorax roundish, wider than long; abdomen broad oval; colors usually bright and variegated.......LEBIA, 32
        - F F. Thorax squarish, longer than wide; abdomen oblong-oval; color blackish: DROMIUS, 13
      - E E. Labial palpi ending in a widened hatchet-shaped joint. Thorax heart-shaped; abdomen oblong-oval.
        - G. Body glabrous. Colors brilliant.......CALLEIDA, 11
        - G G. Body more or less hairy. Colors obscure.......CYMINDIS, 23
- B B. Thorax elongate and slender, much narrower than the head, and without a lateral margin. Claws simple.
  - H. Thorax spindle-shaped. Abdomen oval, convex, tarsi simple. Colors black and red.......CASNONIA, 2
  - H H. Thorax nearly parallel; abdomen oblong, parallel, and depressed; penultimate joint of tarsi deeply bilobed. Elytra not truncated. Color brownish: LEPTOTRACHELUS, 1

A A. Antennæ robust, sub-moniliform, and somewhat widened and compressed towards the tip. Body elongated, parallel and depressed. Legs rather short and robust. Color brown: HELLUOMORPHA, 6

Galerita janus, Fab., is a fine and not uncommon species. The head is black; thorax and legs reddish-yellow, and elytra indigo-blue. *Brachinus fumans*, Fab., nearly half an inch in length, with indigo

wing-covers, and all the other parts reddish-yellow; and several similar smaller species, which seem to pass insensibly into each other, are often found in colonies under stones in dry places. *Lebia* contains many prettily colored species, mostly a quarter of an inch or less in length. *Lebia grandis*, Hentz (Fig. 11), upwards of a third of an inch long, colored much like a Brachinus, is our largest species. This is one of the predacious insects which have been seen to devour the larvæ of the Colorado potato-beetle. The species of Lebia are sometimes found on low or herbaceous plants, and sometimes running up the trunks of trees in search for their minute insect prey.

The genera *Dromius*, meaning a *runner*, and *Calleida*, meaning *beautiful*, have similar habits. *Cymindis* is found under stones. *Casnonia pennsylvanica*, an elegant little insect, quarter of an inch long, and remarkable for its slender spindle-shaped thorax, is usually seen running upon the ground. The head and thorax are black, and the elytra red, with two black bands. It is not a very rare species.

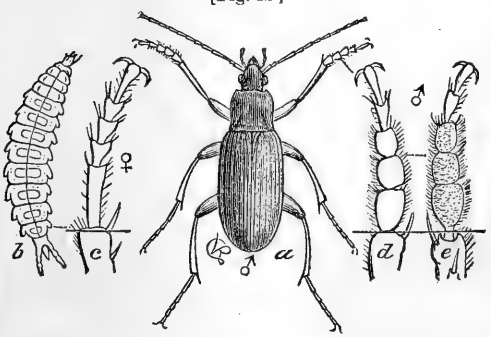
Leptotrachelus also, as its name implies, has a slender thorax, of about the same width throughout. This genus is usually classed in this subfamily, or near it, but it is exceptional in having the elytra entire and completely covering the abdomen.

Helluomorpha, of which we have several species, and the allied genus *Morio*, of which we have but one Southern species, differ from all our other Carabideous insects, in having the antennæ stout and almost bead-like, and either enlarged or strongly compressed toward the tip.

Sub-family CHLÆNIIDES.

The distinctive character of the Chlæniides consists in the structure of the anterior tarsi of the males, which have the three first joints widened, and furnished beneath with crowded points, or hair-like papillæ all of the same length so as to resemble a brush. These joints are usually more or less rounded at the corners, bearing a fanciful resemblance to the *patella* or *knee-pan*, which suggested to Latreille the name *Patellimani*, by which he designated this sub-family; *mani*, meaning *hands*, a term which is sometimes applied by entomologists to the fore-feet of beetles, because they are often constructed and used differently from the others. But

[Fig. 12]



CHLÆNIUS PENNSYLVANICUS, Say:—*a*, male beetle; *c*, front tarsus of female; *d*, front tarsus of male, showing the widened and rounded or patelliform joints; *e*, underside of same, showing the brush-like surface—after Riley: *b*, larva of CHLÆNIUS—after Chapuis and Candèze.

apart from this sexual, and therefore often unavailable character, the Chlæniides can usually be distinguished from the Carabides proper by the presence of the tibial notch, and by their smaller size and more varied colors; from the Scaritides by the absence of the gap between the thorax and the elytra; from the Brachinides by the thorax and abdomen never being of contrasted colors, and by their simple claws; and from the Harpalides by their usually lighter colors and silken surface. But a considerable number of species which are black and hairless, like the Harpalides, are included with the Chlæniides proper on account of the structure of their feet. But these we shall explain more particularly in our references to particular genera.

In a strictly scientific point of view, the Chlæniides can scarcely be regarded as forming a sub-family distinct from the Harpalides, but it is a matter of convenience, in practice, to subdivide very extensive groups. If we regarded structural considerations alone, a large proportion of the Carabidæ would have to be united in one great division, whilst certain anomalous genera such as *Omophron*, *Ozæna*, *Morio*, and a few others, would really constitute the types of distinct sub-families.

A. Body hirsute; head attached by a short neck; abdomen pedunculated; size below medium; colors varied with fulvous and black........PANAGÆUS, 3 sp.

A A. Body finely pubescent; head without neck; abdomen sessile; thorax narrower than abdomen; size about medium; colors mostly green or blue-black........CHLÆNIUS, 35.

A A A. Body glabrous; thorax nearly or quite as wide as abdomen; size medium or above; color black.

B. Body elongated or elliptical; anterior angles of the thorax advanced; elytra carinated near the margin; color black, usually with rich violet or metallic tints........DICÆLUS, 21.

B B. Body oval; thorax and elytra, ordinary color black.

C. Head broad and obtuse; thorax a little narrower at base than elytra; mentum without tooth........DIPLOCHEILA, 3.

C C. Head small and pointed; thorax as wide at base as elytra; mentum toothed.....OODES, 8.

A A A A. Body glabrous; thorax small; size small; color light red with black spots..BADISTER, 8.

Panagæus contains two N. A. species, the *crucigerus* and *fasciatus* of Say, both of which are rare. The generic name means *holy*, in allusion to the arrangement of the spots on the elytra, in the typical species, somewhat in the form of a cross. *Chlænius* contains many species, one of the largest, most beautiful, and commonest of which is the *Chlænius sericeus* of Forst. (fig. 12), a fine green insect, with yellow legs, and clothed, like the rest of the species, with a microscopically fine silken down, or pubescence, which can scarcely be seen directly from above, but which is quite distinct when viewed side-ways, with the aid of a lens. *Dicælus* (*two-pitted*, in allusion to the hollows on the thorax) contains a number of rather rare beetles, some of which are pure black, but most of them are very richly tinted. They can be distinguished from the black Harpalides by their more elongated form, and more particularly by the shape of their thorax, which is almost square, with its anterior angles advanced, and considerably turned up at the sides.

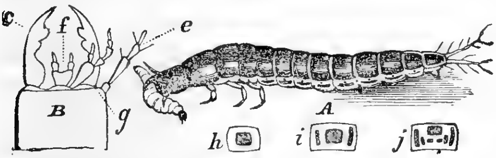
The next two genera resemble still more closely some of the Harpalides, but the structure of the fore-feet of the males places them in the present sub-family. They are easily distinguished, however, from the great majority of the Harpalides, by having the thorax nearly or quite as wide at base as the elytra.

The meaning of the generic name *Oodes*, is, *resembling the letter O*, the species being of a regular oval form, and the thorax and elytra being of precisely the same width and closely applied to each other. In this respect they resemble the genus *Amara* among the Harpalides. The genus *Badister*, meaning *a fast walker*, is composed of a small number of pretty little glossy reddish beetles, spotted with black, a style of coloration in strong contrast with the usually dark colors of the Carabidæ.

Sub-family HARPALIDES.

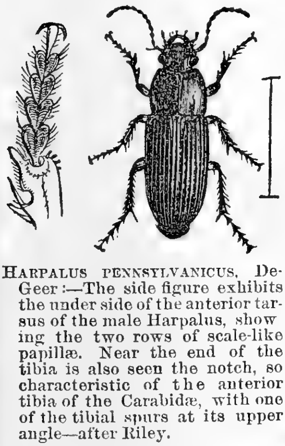
The Harpalides, as here defined, embrace a very extensive group of beetles, not much inferior in numbers to all the other sub-families combined; and as they are mostly of black or dark metallic colors, and as their size is for the most part limited in its range from a quarter of an inch to a little more than half an inch in length, and when we add to this that their most distinctive characters are restricted to the male sex, some idea can be formed of the difficulty of classifying them, or of referring any particular species to its proper location. Their distinctive character lies in the structure of the tarsi of the males, which often have both the anterior and middle tarsi dilated, and instead of having a uniform brush upon the under side, they are furnished with two rows of little transverse plates, or scale-like papillæ, and the hairs which border the sides of the tarsi are usually coarser, or more bristly than they are in the Chlæniides; and the angles of the dilated joints are more prominent. The first section, however, or Anisodactili, have the tarsi brushed underneath like the Chlæniides, but differ from them in having the middle tarsi as well as the anterior ones dilated; and they moreover harmonize better with the Harpalides in their general aspect.

[Fig. 13.]



SUPPOSED LARVA OF HARPALUS (in the act of devouring a Curculio larva):—*B*, head seen from beneath; *j*, *i*, *h*, marks on under side of abdominal segments, becoming fewer towards the tip—after Walsh.

[Fig. 14.]



HARPALUS PENNSYLVANICUS, DeGeer:—The side figure exhibits the under side of the anterior tarsus of the male Harpalus, showing the two rows of scale-like papillæ. Near the end of the tibia is also seen the notch, so characteristic of the anterior tibia of the Carabidæ, with one of the tibial spurs at its upper angle—after Riley.

1. Anterior and middle tarsi of the males with the four first joints dilated.

A. The dilated joints brush-like beneath.

B. Tarsi of the males only dilated; first joint not larger than the others; size never much below medium; color often inclining to brown.................................ANISODACTYLUS, 37.

B B. Tarsi of both sexes dilated; first joint much larger than the others; size small; color mostly black...GYNANDROPUS, 2.

A A. The dilated joints scaly beneath.

C. Mentum usually with a small median tooth; thorax sub-quadrate; tarsi not bilobed; size usually about medium; color black, rarely dark brown or green..........HARPALUS, 54.

C C. Mentum without tooth; thorax rounded; the last of the dilated joints deeply bilobed; size small; color usually wholly or in part light reddish-brown.......STENOLOPHUS, 24.

2. Anterior tarsi of males with four dilated joints, which are scaly beneath; middle tarsi not dilated; mentum toothed; size and color like Stenolophus; thorax somewhat square-shaped: BRADYCELLUS, 26.

3. Anterior tarsi of the males with the three first joints dilated and scaly beneath; middle tarsi not dilated; size about medium or below.

D. Anterior tibiæ rather stout and thickened at the tip.

E. Body more or less elongated; thorax narrower at base than elytra; size various; color mostly pure black...PTEROSTICHUS, 89.

E E. Body elliptical; thorax nearly as wide at base as elytra; three first joints of antennæ carinated; size medium; colors metallic.........................PŒCILUS, 13.

E E E. Body oval; thorax wider than long, and as wide at base as elytra; head small; color black or blackish...AMARA, 38.

D D. Anterior tibiæ slender and scarcely thickened at the tip.

F. Claws pectinate; tibiæ strongly spinous................................CALATHUS, 11.

F F. Claws simple; tibiæ not strongly spinous; size usually below medium; often with metallic tints..PLATYNUS, 96.

4. Anterior tarsi of males with the two first joints dilated, and scaly beneath.

G. Palpi not acuminate; thorax heart-shaped; size medium or below; color almost always shining black...PATROBUS, 14.

G G. Palpi ending in a long pointed joint; thorax various; size small; color usually light brown..TRECHUS, 6.

5. None of the tarsi dilated; head rather broad and not narrowed behind the eyes; size various; color brownish.

H. Anterior tibiæ abruptly widened at the extremity; size large......GEOPINUS, 1.

H H. Anterior tibiæ normal; size small..............................AGONODERUS, 10.

Anisodactylus baltimoriensis, Say, nearly half an inch long, with reddish-brown elytra, and pale legs, is a very common insect, and is often seen flying in considerable numbers in the first hot days of spring. We have a considerable number of small, active, shining light-brown Carabidæ, generally less than a quarter of an inch in length, which belong mostly to the three genera, *Stenolophus*, *Bradycellus* and *Trechus*. The second are distinguished from the first, in addition to the structure of the feet of the males, by the thorax having distinct angles behind, whilst it is rounded in *Stenolophus*. The distinctive character of *Trechus* is the form of the palpi, the last joint being elongate, conical and pointed, and the joint before it being somewhat similar, but reversed, so that the two taken together form a fusiform or spindle-shaped body. *Pterostichus*, Bonelli, is now substituted for *Feronia*, Latreille, on account of the latter term having been previously used in botany. It contains a vast assemblage of species which have been divided into various sub-genera, but without any fixed distinctive characters. We have already spoken of the close resemblance between *Amara* and *Oodes* in the preceding subfamily. The males are distinguished by the structure of their feet, but

the females are scarcely distinguishable. The tooth of the mentum is usually simple in *Oodes* and bifid in *Amara*, but even this character is not invariable. The remark made of *Pterostichus* will apply to *Platynus*. *Calathus* is peculiar in this sub-family for its pectinated claws, and in accordance with this structure its species are often seen on the trunks of standing trees, or under the scales of bark, sometimes in company with *Dromius* and *Lebia*. *C. gregarious*, Say, is not uncommon. *Geopinus incrassatus*, Dejean, has been found in loose soil several feet below the surface. *Agonoderus pallipes*, Fab., is one of our most common insects. It is often attracted into houses by the lamps, in summer evenings. The other species of this genus are rare.

The following are the literal meanings of the foregoing generic terms:

Anisodactylus—having *dissimilar feet.*

Gynandropus—*male* and *female feet*, referring to the widening of the tarsi in both sexes.

Harpalus—*ravenous.*

Stenolophus—having a *narrow neck* or thorax.

Bradycellus—*slow-footed.*

Pœcilus—*changeable*, alluding to their metallic colors, changing in different lights.

Calathus—*a wicker basket*, probably referring to their comb-toothed claws.

Platynus—*depressed.*

Trechus—*a runner.*

The origin of the terms *Amara* and *Patrobus*, is not apparent.

Sub-family BEMBIDIIDES.

This sub-family is composed exclusively of very small species, varying from a twentieth to a little more than a quarter of an inch in length. Their distinctive character consists in the form of the palpi, the last joint being very small and acicular, the contrast being made the more striking by the preceding joint being unusually large and swollen. The species are numerous, upwards of one hundred and forty North American species having been described, arranged in many sections or subgenera. They are almost all of a shining black color, but often exhibit beautiful brown or green reflections. They are extremely agile in their motions. A few of the smaller species are found under the bark of decayed trees, but the great majority inhabit wet places. Mr. Haliday, an accurate English entomologist, relates that some of the species which frequent the sea-shore permit themselves to be submerged by the waves.

TRIBE II.

PREDACEOUS WATER-BEETLES.

Carnivora aquatica, HYDRADEPHAGA,* MacLeay.

These insects are distinguished from those of the first tribe by their feet being fitted for swimming, the two hinder pairs being much flattened and margined with long hairs or ciliæ.

This tribe contains two families.

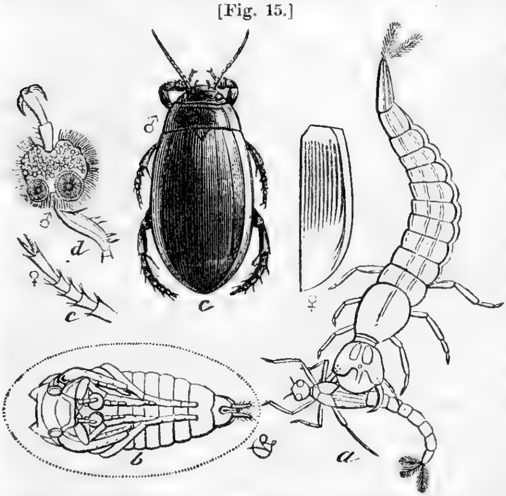
A. Antennæ slender, filiform; hind legs long, and attached to the breast far behind the other two pairs .... DYTISCIDÆ.

A A. Antennæ very short and peculiar; the three pairs of legs attached at nearly equal distances from each other; middle and hind legs very short .... GYRINIDÆ.

Family III. DYTISCIDÆ.

This family is founded upon the genus *Dytiscus*, of Linnæus, derived from a Greek word meaning a *diver*, and given to these insects on account of their eminently aquatic habits. They are of an oval and somewhat flattened form, and of a brownish-black color, generally with a dull glaucous or sea-green tint. In some species the thorax is dull yellow, either with or without black cross-bars. One of their most distinctive and easily recognized characters is the position of the middle legs close to the anterior ones, leaving an unusually long space between the middle and the hind legs. These insects are eminently aquatic and predaceous, and may be supposed to represent the sharks and other ferocious aquatic animals of the higher classes.

[Fig. 15.]



DYTISCUS:—*a*, larva of *D. marginalis* devouring a larva of Ephemera—after Rœsel: *b*, pupa of same—after Rye: *c*, *D. fasciventris*, Say, the detached figure on the right showing the grooved elytron of the female; *d*, the anterior tarsus of the male, under side, showing the suction cups; *e*, same of female—after Riley.

They have sometimes been found very troublesome in artificial fish-ponds, attacking the young gold and silver fishes and eating off their

* From the Greek *hudor—water*; and *adephagos—ravenous*.

fins. The larvæ leave the water and make little cavities in the earth, when about to transform. Two hundred and thirty North American species have been described, arranged, for the most part, in the following genera:

A. Antennæ 10-jointed; hind coxal plates greatly dilated, so as to cover half of the abdomen; legs slightly natatorial; size small; form somewhat pointed before and behind; color yellowish spotted with blackish.......... HALIPLUS, 15.

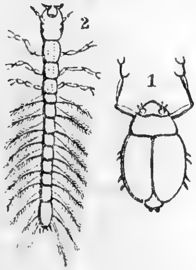
A A. Antennæ 11-jointed; coxal plates obsolete; legs strongly natatorial.

- B. Tarsi distinctly 5-jointed, not bilobed; scutellum distinct (except in Laccophilus).
  - C. Anterior tarsi of males widened and forming a rounded disk with cups beneath of very unequal size; generally large or medium-sized insects.
    - D. Hind tarsi with one claw; size very large, exceeding an inch in length.......... CYBISTER, 3.
    - D D. Hind tarsi with two claws.
      - E. Claws equal, or nearly so; size large, or very large.......... DYTISCUS, 11.
      - E E. Claws unequal.
        - F. Body oval, depressed; size about medium.......... ACILIUS, 6.
        - F F. Body elliptical; convex; size below the medium.......... HYDATICUS, 9.
  - C C. Anterior tarsi of males widened, with the joints oblong and with cups of about equal size; size usually below medium.
    - G. Scutellum distinct; length between a quarter and a half of an inch.
      - H. Hind claws unequal; form less convex.......... COLYMBETES, 25.
      - H H. Hind claws equal; form more convex.......... AGABUS, 47.
    - G G. Scutel wanting; hind legs stout, compressed; length quarter of an inch or less: LACCOPHILUS, 9.
- B B. Tarsi apparently 4-jointed; third joint bilobed; scutellum wanting; size very small: HYDROPORUS, 91.

Family IV. GYRINIDÆ.

Founded upon the genus *Gyrinus*, a name derived from a Greek word meaning a *circle*, and given to these insects on account of their habit of swimming round in little circles upon the surface of the water. The antennæ are very short and peculiar, and of the form called *auriculate*. The second joint is large and ear shaped, and the following ones form a short spindle-shaped mass. They are inserted in a little cavity in front of the eyes. The middle and hind legs are very short, scarcely reaching beyond the sides of the body, and very broad and flat like little plates. These insects are of a medium or small size, of a shining blue-black color, and are often seen in dense flocks playing and gyrating upon the surface of still water. Number of N. A. species, thirty-seven.

Fig. 16.



GYRINUS:—1, beetle; 2, larva—after Packard.

Second Sub-section, **CLAVICORNES.**

Antennæ club-shaped. Subsist mostly upon decaying animal or vegetable substances.

TRIBE III.

WATER SCAVENGER-BEETLES.

Putrivora aquatica, PHILHYDRIDA,* MacLeay.

This tribe commences the series of beetles with clubbed antennæ, a character which at once distinguishes the insects of this tribe from the predaceous water-beetles, with which they might otherwise be confounded on account of their aquatic habits and similarity of form. This tribe is composed of two very distinct sub-tribes.

Sub-tribe 1. *Macrodactyla*, Latreille. Legs not fitted for swimming. Last joint of the tarsi very long, often as long as all the others united, and for this reason called Macrodactyla, which means *long-toed.* Palpi of ordinary length. Antennæ moderately clavate. Body clothed with silken hairs. Family, Parnidæ.

Sub-tribe 2. *Palpicornes*, Latreille. Legs fitted for swimming (except the Sphæridiidæ). Palpi very long, usually longer than the antennæ. Antennæ strongly clavate. Body glabrous.

These insects feed upon decomposing matter in water, and are one of the agencies which prevent water from becoming offensive in a state of nature. But some of them have been observed to be carnivorous in the larva state.

The first sub-tribe are semi-aquatic, being found in mud, or adhering to stones under water by means of their stout claws. The second sub-tribe (except the Sphæridiidæ) are purely aquatic, but less rapid in their motions than the predaceous water-beetles. Each of the sub-tribes is represented by one principal family, the Parnidæ representing the first division and the Hydrophilidæ the second.

Family V. PARNIDÆ.

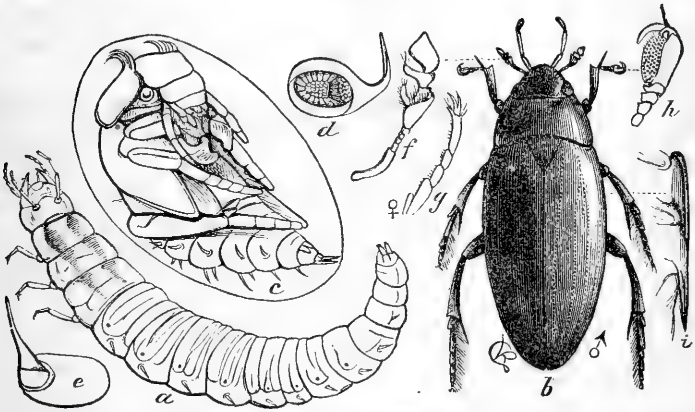
These are small sub-aquatic insects which have been sufficiently characterized above. The family is composed of three leading genera. *Parnus*, Fab., having the antennæ enlarged at base and at tip, and the hind coxæ dilated into a plate for the protection of the thighs; *Elmis*, Latr., with the antennæ almost filiform, and the hind coxæ not dilated; and *Heterocerus*, Fab., with the antennæ much like Parnus, but the mouth organs are more strongly developed, and the anterior and middle tibiæ are widened and armed with spines on the outer edge, by which they are enabled to burrow in the wet sand which they and their larvæ inhabit.

*From the Greek *phileo—to love*; and *hudor—water.*

The last genus is regarded by many as constituting the type of a small family distinct from the Parnidæ. Most of these imperfectly aquatic insects are clothed with fine silken hairs which seem to have the property of shedding the water, and of enabling the insect to surround its body with a globule of air whilst clinging to the stones beneath the surface; whereas the purely aquatic beetles, the Dytiscidæ, the Gyrinidæ and the Hydrophilidæ, which have the faculty of swimming and of rising to the surface of the water whenever they need a fresh supply of air, have no such clothing. Forty-eight N. A. species are known. A synopsis of the Parnidæ of the United States is given by Dr. Geo. H. Horn in the 3d. vol. of the Tran. Am. Ent. Society.

Family VI. HYDROPHILIDÆ.

[Fig. 17.]



HYDROPHILUS:—*a*, larva of *H. piceus*, Linn.; *e*, egg-case; *d*, same opened showing arrangement of eggs; *c*, pupa—after Blanchard: *b*, *H. triangularis*, Say., natural size; *f*, antenna; *g*, anterior tarsus of female; *h*, same of male, all magnified; *i*, side view of the sternal spine—after Riley.

This family is named from the genus Hydrophilus, a word of Greek composition meaning a *lover* of *water*. They constitute a somewhat extensive series of water-beetles, but less numerous and less eminently aquatic than the Dytiscidæ. In swimming they move the hind legs alternately, whilst the Dytiscidæ strike with them both together like a frog. Both of these families contain both large and small species, the largest being an inch and a half in length. Many of the larger species of Hydrophilidæ have the sternum or breast bone in the form of a keel, and prolonged posteriorly to a sharp point. They are essentially distinguished from the predaceous water-beetles by their short clavate antennæ and their long palpi, which are usually longer than the antennæ, and are carried projecting forwards whilst swimming. The larvæ of Hydrophilus are predaceous. The names of one hundred and twenty-two N. A. species are given in Dr. LeConte's catalogue, inclusive of twenty-one species of the small sub-family of Sphæridiides.

A. Middle and hind tarsi with the first four joints short; the last often as long as all the others; body oblong; thorax furrowed, and narrower than the elytra; size small...... HELOPHORUS.

A A. Middle and hind tarsi with second joint elongated, first very short; body oval; thorax as wide at base as elytra.

B. Metasternum keeled and prolonged backward into a sharp spine; tarsi flattened; size large or very large........ HYDROPHILUS.

B B. Metasternum not prolonged; tarsi not compressed; size small or very small.

C. Hind tibiæ and tarsi ciliate; scutellum elongated........ BEROSUS.

C C. Hind tibiæ and tarsi not ciliate; scutellum regularly triangular........ HYDROBIUS.

A A A. Middle and hind tarsi with the first joint elongated; body short and sub-globular; size very small; not aquatic; found in cow-dung........ SPHŒRIDIUM.

TRIBE IV.

LAND SCAVENGER-BEETLES.

Putrivora terrestria, NECROPHAGA *partly*, Latreille.

This tribe embraces an extensive series of useful scavengers, whose office it is to hasten the decomposition and removal of dead organic matter. The typical species are found upon dead animals or other decomposing animal substances. Some of the smaller species are found under the bark of dead trees; whilst others feed upon fungi, especially those which grow upon decaying trees. The only other insects which can be compared with these in usefulness as scavengers, is the extensive family of *Muscidæ*, in the two-winged flies. It is interesting to observe the order in which these various tribes of scavenger insects perform their respective parts. First come the Muscidæ, which, in the form of carrion flies, deposit their eggs or *fly-blows* upon dead animal matter at the first moment of decay, and, in very hot weather, almost immediately after life has ceased. Soon after these come the carrion-beetles, the Silphæ and Necrophori, whose larvæ, like the maggots of the flesh-flies, are seen revelling in the putrescent matter at the most offensive stage of decomposition. When the softer parts have been devoured and only the osseous and ligamentary portions remain, other families of scavengers succeed, namely: the skin-beetles, *Dermestidæ*, and the bone-beetles, *Necrobii* and *Nitidulæ*, which adhere to the dried carcass as long as any vestige of animal matter remains.

The scavenger-beetles, with a few exceptions, are readily distinguished from the other pentamerous Coleoptera by the form of their antennæ, which, in the great majority, are strongly clavate, and sometimes capitate or knobbed.

The number of joints in the tarsi are much more variable in this than any other tribe or section; and though the larger species very uniformly possess five joints in all the tarsi, in many of the very small species one of the joints, especially in the posterior tarsi, is either rudimental or wanting. The place of these insects in the system has to be determined therefore by the examination and collection of their other characters.*

* See suggestions on pages 30 to 34.

Indeed, in some of the families which are usually classed with the pentamerous clavicorns, both of the leading characters, the clubbed antennæ and the five-jointed tarsi, either partially or wholly fail. Some of these insects also depart widely in their habits from the scavengers proper, and might therefore very properly be separated as a tribe by themselves were it not for the absence of any very strongly marked community of characters. In order to guard against mistake we have thought it best to throw these exceptional families together, as a sub-tribe, under the title of sub-clavicornes.

The tribe of land-scavengers may therefore be divided into two sub-tribes differing very considerably from each other, both in structure and habits, and which may be distinguished as follows:

1st Sub-tribe.—*Clavicornes*, proper. Body more or less oval; antennæ clavate or capitate; usually three, sometimes more than three joints in the club; usually five joints in all the tarsi, or, at least, in the anterior ones; subsist mostly upon animal or vegetable substances, in a state of decay. This division includes the families Silphidæ, Scaphidiidæ, Histeridæ, Nitidulidæ, Dermestidæ, Mycetophagidæ, Cryptophagidæ, Byrrhidæ, Anisotomidæ, Phalacridæ, Trichopterigidæ and Scydmenidæ.

2d Sub-tribe.—*Sub-clavicornes*. Body more or less elongated; antennæ almost filiform, or granose, or moderately and loosely clavate, sometimes with less than three joints in the club; tarsi, in many, less than five-jointed. Found mostly under the bark of dead trees. They never feed upon dead animal matter, but recent observations show that many of them are carnivorous or vermivorous, at least in their larva state, preying upon the soft larvæ of the wood and bark-eating insects. Composed of the families Trogositidæ, Cucujidæ, Colydiidæ and Lathridiidæ.

FAMILIES OF LAND-SCAVENGERS

Sub-tribe 1st. CLAVICORNES.

A. Body oval or elliptical; antennæ clavate or capitate. Anterior tarsi almost always five-jointed.
  B. Large insects, the smaller not much less than half an inch in length (except Catops.) Hind trochanters prominent. Thorax with a thin margin.................. SILPHIDÆ.
  B B. Small insects less than half an inch, mostly less than quarter of an inch in length.
    C. Wing-cases shorter than the abdomen.
      D. Abdomen thick, conical and pointed, first segment very long.................................. SCAPHIDIIDÆ.
      D D. Abdomen rounded behind.

E. Head very small and retractile. Body very hard, color shining black.......................................HISTERIDÆ.

E E. Head moderate. Color usually dull brown, with or without spots......................NITIDULIDÆ.

C C. Wing-cases covering the whole abdomen.

F. Head inserted in the thorax; thorax as broad at base as the abdomen.

G. Wings not fringed with long hairs.

H. Body moderately convex, pubescent. Antennæ strongly clavate.

J. Prosternum advanced beneath the retractile head.........................DERMESTIDÆ.

J J. Prosternum not advanced.

K. Body strongly pubescent, often prettily spotted................MYCETOPHAGIDÆ.

K K. Microscopically pubescent, generally unspotted..............CRYPTOPHAGIDÆ.

H H. Body very convex, or sub-globular.

L. Medium or small insects; body thick, ovoid, pubescent, sometimes variegated: BYRRHIDÆ.

L L. Very small insects; body glabrous, black, rarely spotted with red.

M. Club of antennæ 3 or 5-jointed. Body usually contractile into a ball: ANISOTOMIDÆ.

M M. Club 3-jointed. Body not contractile: PHALACRIDÆ.

G G. Wings fringed. Size minute. Tarsi 3-jointed: TRICHOPTERIGIDÆ.

F F. Head, free. Abdomen, much wider than the ovoid thorax. Size very small........SCYDMÆNIDÆ.

Sub-tribe 2d. SUB-CLAVICORNES.

A A. Body usually elongated. Antennæ slightly clavate, or filiform and granose. Tarsi often with less than five joints.

N. Body somewhat depressed, smooth. Tarsi five-jointed, first joint very small. Color black, or dark red..TROGOSITIDÆ.

N N. Body very flat, smooth. Color red or brown..CUCUJIDÆ.

N N N. Body not very flat; sometimes cylindrical, usually deeply sculptured, or scabrous. Tarsi less than five-jointed.

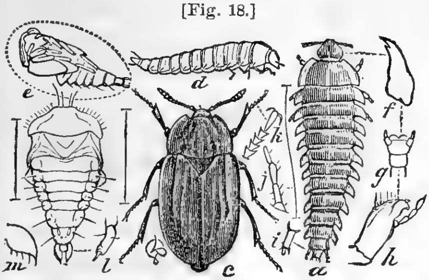
O. All the tarsi four-jointed......................COLYDIIDÆ.

O O. All the tarsi three-jointed.................LATHRIDIIDÆ.

Family VII. SILPHIDÆ.

This family is founded upon the genus *Silpha*, a name originally given by the Greeks to some kind of fœtid beetle, and appropriated by Linnæus to the leading genus of the present family. These insects are most readily distinguished from the other Necrophaga by their large size. The species of Silpha are usually half an inch and upwards in length, whilst some of the burying beetles, composing the genus Necrophorus, are an inch and a half. The other leading characters are the orbicular or rounded thorax, very thin all around at the margin, and slightly overlapping the base of the elytra. The club of the antennæ is perfoliate and 4 or 5-jointed. The hind trochanters are also prominent, especially in Necrophorus; but they are not swolen or sub-globular, as they are in the land predaceous beetles. The Silphæ, in company with their larvæ, are found on dead and putrid animals.* The Necrophori have the curious instinct to deposit their eggs in small dead animals or fragments of putrid flesh, and then bury them in the ground several inches, and sometimes nearly a foot in depth. The larvæ hatching from these eggs feed upon the decayed flesh, and, it is said, devour even the bones of small animals.

[Fig. 18.]



SILPHA INÆQUALIS, Fab:—*a*, larva; *d*, same, natural size; *f*, *g*, *h*, mandible, labium, and maxilla of larva; *i*, *j*, anal process and antennæ of same; *m*, one of the lateral processes more highly magnified; *b*, pupa; *e*, same, natural size; *l*, anal process of same; *c*, beetle; *k*, anterior tarsus of same—after Riley.

There is a small group of dusky or blackish beetles belonging to the genera Catops and Colon, which are less than a quarter of an inch in length, which are usually classed with the Silphidæ, and consequently form an exception to the majority of the family with respect to size.

Fifty-five North American species have been described.

The three leading or typical genera may be thus described:

A. Antennæ capitate; head large and free. Large thick bodied insects; color black, elytra spotted with reddish-yellow .... NECROPHORUS.

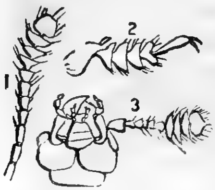
A A. Antennæ clavate and perfoliate; head small; size medium; body broad and flattened; color black; thorax in many margined with yellow .... SILPHA.

A A A. Antennæ sub-clavate; head partly immersed in the thorax; size small; form ovate; color black or brown .... CATOPS.

* A remarkable exception to the usual habits of this family, occurs in the case of a small European species, (*Silpha opaca*, Linn.) the larvæ of which have been known to feed, to an injurious extent, upon the leaves of the beet and the mangel-wurzel. Curtis' Farm Insects, p. 388.

The *Necrophorus Americanus* is nearly an inch and a half in length. The other species do not exceed an inch, and a few of the smaller species scarcely exceed half an inch in length. *Silpha Americana* has the thorax broadly margined with yellow; *S. marginata* has the thorax margined with red; *S. inequalis* [Fig. 18] is wholly black; *S. caudata* has adull bronze thorax, and black elytra, with many small tubercles. The *Necrodes surinamensis* is black, with a reddish spot near the end of each elytron, and the elytra strongly carinated or ridged. Necrodes differs from Silpha in having a more elongated form, and the antennæ with a greater number of perfoliate joints.

[Fig. 19.]



NECROPHORUS: —1, antennæ; 2, tarsus; 3, head from beneath — after Westwood.

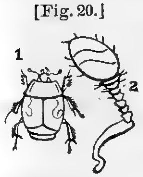
Family VIII. SCAPHIDIIDÆ.

From the genus *Scaphidium* of Olivier, a name meaning a *little skiff* or *boat*, and given to these insects on account of their fancied resemblance to a boat, being thickest and arched in the middle, and narrowed towards each end, the head being very small, and the tip of the abdomen being conical and pointed, and projecting beyond the end of the wing-cases. The first abdominal segment is unusually long. These are small, shining-black insects found in fungi and rotten wood. They move rapidly, but with an uneven or skipping gait. They constitute a very small family, only seventeen N. A. species having been described at the present time.

Family IX. HISTERIDÆ.

Founded upon the genus *Hister* of Linnæus, a term borrowed from the Latin *hister*, or *histrio*, meaning a *stage actor* or *mimic*, and applied to these insects on account of their habit of persistently feigning death when captured; a habit, however, which they have in common with many other Coleoptera. They are mostly small, short, rounded or somewhat square-shaped beetles, of a very hard consistency, and a glossy black color, very rarely marked with a few red spots. They are further distinguished by their small heads, which can be retracted into the thorax, so as to be nearly or quite invisible; and also, by their truncated or shortened wing-cases, leaving the two last abdominal segments exposed. They live in the excrement of animals, and other decomposing substances, mostly animal, but sometimes vegetable.

[Fig. 20.]



HISTER:—1, beetle natural size; 2, antennæ of same magnified—after Westwood.

Number of described N. A. species, one hundred and eighty-four.

The following are the three typical genera:

A. Head porrected; mandibles as long as the head; body very flat; size comparatively large—HOLOLEPTA.

A A. Head retracted; mandibles short; body usually convex, (flattened in sub-genus Paromalus.)

B. Prosternum advanced so that the head is invisible from beneath........................HISTER.

B B. Prosternum not advanced..SAPRINUS.

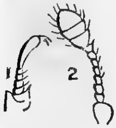
Hister is divided by Dr. LeConte into ten lesser genera, which De Marseul has still further subdivided so as to form four additional ones. These divisions are made in accordance with slight organic variations, which however are sometimes accompanied by differences in size, or by perceptible modifications of the general form.

More recently, Dr. Geo. H. Horn has contributed to the American Philosophical Society (June, 1873,) a valuable synopsis of the Histeridæ of the United States, in which all our species are carefully reviewed and described.

Family X. NITIDULIDÆ.

The typical insects of this family constitute the genus *Nitidula* of Fabricius, a word literally meaning *shining*, or *elegant*, but which is singularly inapplicable to the insects of this family, as now constituted, most of which are clothed with a fine pubescence, which is incompatible with a shining surface. They are small, somewhat flattened beetles, the thorax having a wide, thin margin, and the wing-cases more or less cut off behind, so as to leave the end of the abdomen exposed. In the sub-family of Carpophilides, the elytra are so short as to leave two or three of the abdominal segments uncovered, but in the Nitidulides only the tip of the abdomen is exposed. The fourth tarsal joint is very small, and wholly wanting in the hind tarsi of the males of some species. Their colors are usually brown or blackish, with or without dull yellow spots.

[Fig. 21.]



NITIDULA:—1, anterior tarsus; 2, antennæ—after Westwood.

The insects of this family vary much in their habits. Some are found on carrion and others on flowers; several of the most common species are often met with on apples and other fruit in a state of decay. The larvæ of the genera Ips Carpophilus and Rhiozophagus, have been shown by the observations of a French author, M. Ed. Perris, to be carnivorous, subsisting upon soft, sub-cortical larvæ.

Ninety N. A. species have been described, under the following principal genera:

A. Antennæ 11-jointed, club 3-jointed; body oval.

B. Only the tip of the abdomen exposed.

C. Surface pubescent; colors dull; upper lip exposed.

D. Body depressed; thorax not overlapping the elytra; color brown, usually with obscure yellow spots........................NITIDULA.

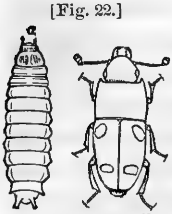
D D. Body convex; thorax slightly overlapping the base of elytra. Color brown, usually shaded with black........................CYCHRAMUS.

C C. Surface smooth and shining; color black, spotted with yellow or reddish; labrum concealed: IPS.

B B. Two or three last segments of abdomen uncovered by elytra....................CARPOPHILUS.

A A. Antennæ 10-jointed; club solid; body elongated................................RHIZOPHAGUS.

[Fig. 22.]

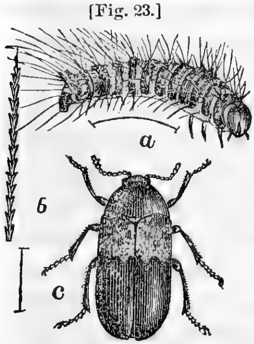


IPS FASCIATUS:—Larva and beetle—after Packard.

Ips fasciatus, a shining black species, quarter of an inch long, with two conspicuous, interrupted reddish bands across the elytra. *Nitidula bipustulata*, a blackish brown insect, with a yellow dot on the middle of each elytron, one-sixth of an inch long; and *Omosita colon*, a little species one-tenth of an inch in length, brown, the elytra pale at the tips with two minute dots, like a colon—are the three most common species.

Family XI. DERMESTIDÆ.

[Fig. 23.]



DERMESTES LARDARIUS, Linn.:—*a*, larva; *b*, one of the larval hairs greatly magnified; *c*, beetle—after Riley.

This family is founded upon the genus *Dermestes*, of Linnæus, a name derived from the Greek *derma—a skin*, and *esthio—to devour*, and applied to these insects because some of the species are destructive to skins and furs, and other dried animal substances. They differ from the three preceding families in having the abdomen completely covered by the wing-cases; but they are more particularly distinguished by having the sternum or breast-plate advanced under the mouth like a chin-cloth; by their short and contractile legs and antennæ, and by their coloration, which consists of light-colored spots on a darker ground, the spots being produced by minute scales which can be rubbed off. The larvæ are rather hard, brown, active grubs, more or less clothed with stiff hairs, which usually form a long brush at the end of the body. Forty-nine N. American species have been described.

A. No ocellus or eye-like spot on the front. Size from quarter to half an inch in length: DERMESTES.

A A. Frontal ocellus distinct; less than quarter of an inch in length.

B. Middle coxæ not widely separated .... ATTAGENUS.

B B. Middle coxæ widely separated; size very small .... ANTHRENUS.

The *Dermestes lardarius*, Linn., so called because it is usually found upon refuse lard and bacon, is our most common species. It is an oblong oval, black beetle, one-third of an inch in length, with a broad, brownish-yellow band across the middle of its body, and in the middle of this band a transverse row of black dots.

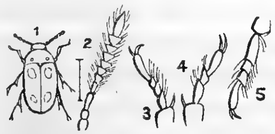
Another species often found in houses, is the *Attagenus pellio*, which, like the former, was originally an European insect, but which has now become distributed over the civilized world. It is two-tenths of an inch long, black with a white dot on the middle of each wing-cover, which is wanting in some specimens, having probably been rubbed off. The larvæ destroy dried skins, furs and woolens, and are said even to gnaw

linen and cotton fabrics. They are sometimes quite injurious to carpets whilst lying upon the floor. We have known them to select a particular stripe, especially one of red flannel, in the domestic fabric known as rag-carpet, and follow it out into the middle of the room, gnawing it off at intervals. They have to be treated upon general principles, no specific remedy, we believe, having been discovered. Some very small species, belonging to the genus Anthrenus, are very destructive to cabinets of natural history. Other small species are found on flowers.

Family XII. MYCETOPHAGIDÆ.

Founded upon the genus *Mycetophagus*, a word which means a *mushroom-eater*, and therefore indicates the habits of the family. They are small, or very small, oval, moderately convex, pubescent, and usually prettily marked insects. This is one of the families of small Coleopterous insects in which the number of tarsal joints is very variable, not unfrequently differing in the sexes of the same species.

[Fig. 24.]



MYCETOPHAGUS:—1, beetle; 2, antenna; 3, anterior tarsus of male (?); 4, same of female (?); 5, posterior tarsus—after Westwood.

The only preceding family with which it is liable to be confounded, is that of the Nitidulidæ; but it differs: first, in the antennæ, which are knobbed in Nitidulidæ, and usually gradually clavate in the Mycetophagidæ; second, in the elytra, which cover the whole abdomen in the latter, and are almost always truncated, though often but very slightly in the former; and thirdly, in the character of the pubescence or down upon the surface, which is scarcely perceptible or wanting in the former, whereas the Mycetophagidæ are densely clothed with prostrate hairs. They are also more uniformly and conspicuously spotted than the Nitidulidæ, the elytra usually exhibiting yellow spots or bands on a brown or blackish ground.

Our largest species is the *M. punctatus*, Say, upwards of two-tenths of an inch in length, blackish; elytra reddish-yellow, with a large black spot including the scutellum, another at the side, and another near but not including the tip.

M. flexuosus, Say, is three-twentieths of an inch in length, blackish; elytra redish-yellow; a large transverse black spot on the region of the scutellum; a small rounded one on the shoulder; a large irregular one on the side, sometimes extending to the suture, and a large black spot on the tip, enclosing a small fulvous spot.

About twenty N. A. species are known.

Family XIII. CRYPTOPHAGIDÆ.

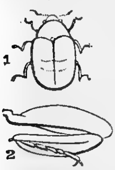
This family name means essentially the same as the preceding one, and implies that the insects which compose it feed upon Cryptogamous plants, which include the mushrooms and fungi. They are very small insects, usually less than one-tenth of an inch in length, of a light-yellowish brown color, and usually having a silken lustre, produced by a microscopically fine pubescence. They are distinguished from the Mycetophagidæ by their usually smaller size, their finer pubescence, the absence of spots, and in the typical and most numerous genus by little saw-like teeth along the sides of the thorax. The *C. cellaris* and *C. crinitus* are often found in cellars.

Upwards of thirty N. A. species have been described.

Family XIV. BYRRHIDÆ.

The Byrrhidæ are distinguished from all other pentamerous clavicorns by their short and very strongly arched or convex bodies, taken in connection with the hairs or minute scales by which the surface of their bodies is more or less clothed and ornamented. The family includes moderately large and very small species—some of the species of the typical genus Byrrhus* being from one-quarter to one-half of an inch in length. All the other beetles of this tribe, which have very strongly convex or sub-globular bodies, are distinguished from the Byrrhidæ by being small or very small insects, with a shining or polished surface. The Byrrhidæ are further distinguished by the extreme contractility of their members—the joints of their legs being capable of being shut so closely upon each other and upon the body, that they are scarcely distinguishable, except upon close inspection. This, together with their sub-globular form, suggested to Linnæus the specific name of *pilula*, for a European species, from its resemblance to a pill or little ball of inanimate matter. These insects are found upon the ground, often in sandy situations, also at the roots of trees and grass. Some species are known to feed upon the mosses.

[Fig. 25.]



BYRRHUS:—1, beetle; 2, hind leg, partially folded up and seen from within—after Westwood.

Thirty-two N. A. species are known.

* This name, which is supposed to have been derived from the Greek *bursa*—a *hide*, from some fancied resemblance in texture, was originally given to these insects by Linnæus, in the twelfth edition of the *Systema Naturæ*, in 1766. Mr. Crotch, in his recent Check List of N. A. Coleoptera, suppresses this name and adopts the name of Cistela, previously given to this genus by Geoffroy, but since applied to a genus of heteromerous beetles. But we prefer to retain the name given by Linnæus, and established by universal usage for more than a century.

Family XV. ANISOTOMIDÆ.

This family of minute Coleoptera is composed chiefly of the genera *Anisotoma* and *Agathidium*, of Illiger. The first term signifies *unequal division*, and has reference probably to the structure of the antennal club, which, in the sub-family Anisotomides, consists of five joints, the second of which is the smallest. Mr. Westwood regards the second genus as the type of the family, which accordingly he denominates AGATHIDIIDÆ. But the other term is adopted by the most recent writers. These insects are remarkable for their very small size and their sub-globular bodies, those of the sub-family Agathidiides having the power to contract the head and thorax upon the abdomen so as to form a little ball. The thorax is orbicular with thin edges, like that of the comparatively gigantic Silphidæ, with which, indeed, they are united as a sub-family by the principal modern authorities, such as Erichson, Lacordaire and LeConte.

These minute insects are found mostly in fungi and rotten wood, and can frequently be caught flying in the evening.

Number of described N. A. species, thirty-five.

Family XVI. PHALACRIDÆ.

A small family of very small, convex, shining black insects, sometimes two-spotted or tipt with red; formerly confounded with the preceding family, but separated from it by a Swedish naturalist, Paykull, under the generic name of *Phalacrus*, a word meaning *bald-headed*, and suggested probably by the rounded, shining aspect of these beetles. They differ from Anisotoma in having but three joints in the club of the antennæ, and from Agathidium in not being contractile, nor in having the hind margin of the thorax overlay the base of the elytra. They differ also in their habits from the foregoing family, being usually found upon flowers.

Twenty N. A. species have been described.

Family XVII. TRICHOPTERYGIDÆ.

This family surpasses the two former in the minuteness of its species —the largest not exceeding small pin-heads in size, and the smallest not being one-quarter as large—the species varying from about one-twentieth to one-seventieth of an inch in length. Nevertheless, it is one of the wonders of nature that within the almost infinitissimal compass of their minute beings are contained all the divisions, the limbs and organs of the most gigantic species. The family is founded upon the genus *Trichopteryx*, of Kirby—a term meaning *hairy-winged*, in reference to the peculiar construction of the inferior or true wings, which are com-

posed of a little lamella or plate, supported at the end of a slender foot-stalk, and ornamented with a fringe of long hairs. In some the wings are wanting. The elytra are sometimes truncated. The club of the antennæ is usually four, rarely two jointed. The tarsi are only three jointed, with a club-tipt bristle between the claws. The surface is often pubescent. Some live in rotten wood and others in manure; a few have been found in ants' nests.

Thirty-eight N. American species have been described.

Family XVIII. SCYDMÆNIDÆ.

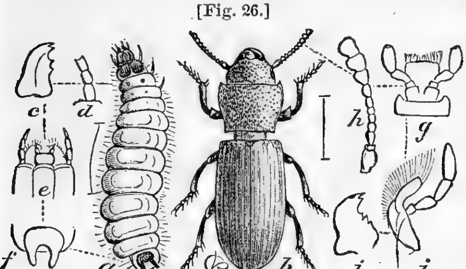
This is another family of very small insects, found under stones or in waste matter, and in ants' nests. They are of a brown color, and are clothed with erect hairs. They are frequently seen flying in twilight. They are very easily distinguished from the small beetles of the three preceding families, by their more oblong ovate form, by the head sepa rated from the pro-thorax by a distinct neck, and by their large abdomens, much wider than the somewhat egg-shaped thorax. They bear the closest relationship to the more extensive family of Pselaphidæ, treated of below, from which, however, they are strongly separated by their five jointed tarsi, and their elytra covering the whole abdomen.

Thirty-eight N. A. species already described.

Family XIX. TROGOSITIDÆ.

Founded upon the genus *Trogosita*, of Olivier, a name composed of the Greek words *trogo—to eat*, and *sitos—grain*, and originally applied to the most notorious species, the *Trogosita mauritanica*, *(Tenebrio mauritanicus*, Linn.) because it is often found in great numbers in worm-infested granaries. But observations recently made upon the carnivorous habits of other species of the genus, render it probable that the larvæ of the *T. mauritanica* live upon the larvæ of the Calandræ and Tiniæ, which are the real authors of the damage. This view is confirmed by our own observations upon the larva of a common American species, the *Trogosita corticalis*, of Melsheimer, which we have seen preying upon the larva of the Codling-moth *(Carpocapsa pomonella)*. The Trogositidæ are oblong, somewhat depressed or flattened beetles, of a black or reddish black

[Fig. 26.]



TROGOSITA CORTICALIS, Melsh.:—*a*, larva; *c*, its mandible; *d*, antenna; *e*, under side of head; *f*, the two-horned anal plate; *b*, the beetle; *h*, its antenna; *i*, mandible; *g*, labium and its palpi; *j*, one of the maxillæ and its palpus—after Riley.

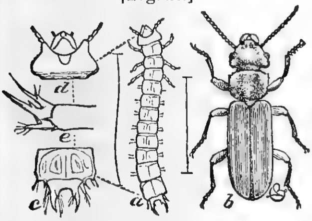
color, usually found under the bark of decaying trees. Their antennæ are short, but reaching back, at most, beyond the middle of the thorax. The club consists of three somewhat moniliform joints, not conspicuously larger than the preceding ones. The tarsi are apparently four jointed, the first joint being so short that it cannot be seen from above; the last joint is very long, often as long as all the others united. In Trogosita proper, the thorax is separated from the abdomen by a short neck or strangulation. The larva of Trogosita is a whitish flattened grub, with a pair of black spots on the top of the three first segments. The tail terminates in two horny points.

Number of N. A. species, forty.

Family XX. CUCUJIDÆ.

The insects of this family are most conspicuously distinguished by their very flat bodies and by their projecting mandibles. Antennæ usually longer than the head and thorax, filiform, and generally granose or moniliform. In the small subfamily of Silvanides, the three last joints are moderately enlarged. The tarsi, like those of the preceding family, are apparently four jointed, the first joint being very small. Both of these families are classed by Latreille with the Tetramera. Most of these insects are brown, but some of the Cucuji proper are of a bright red color. They are found under the bark of trees, but the larvæ, so far as they have been observed, are found to be carnivorous. M. Perris discovered the larvæ of *Brontes planatus* feeding upon Poduræ, acari, and the larvæ of the wood-boring beetles of the genus Tomicus. And in England, Mr. C. C. Babington and Mr. Westwood saw the *Cucujus testaceus* in abundance in granaries, from which, in connection with the similarity of the larvæ, we may conclude that they have the same useful habit as the insects of the preceding family in counteracting the ravages of the destructive grain worms.

[Fig. 27.]



CUCUJUS CLAVIPES, Fabr.:—*a*, larva; *c*, *e*, enlarged back and side views of its anal joint; *d*, of its head; *b*, beetle.—after Riley.

Number of described N. A. species, forty-two.

The following is a table of the principal genera:

A. Antennæ moniliform, not thickened at the tip, half as long as the body, or less; size, more than one-quarter of an inch in length.
  B. Posterior angles of the head rounded and prominent; color, scarlet.......CUCUJUS.
  B B. Posterior angles of the head not prominent; color, brown.......CATOGENUS.
A A. Antennæ sub-moniliform, more than half as long as the body, usually a little thickened at the tip; size, very small.......LÆMOPHLŒUS.
A A A. Antennæ long and filiform, first joint elongated; size, small.......BRONTES.*
A A A A. Antennæ with the last three joints forming a loose club; size, very small.......SILVANUS.

*This name, given to this genus by Fabricius, is discarded in Mr. Crotch's Check List as having been preoccupied, and *Uliota*, Latreille, substituted.

Cucujus, Fab., contains but one N. A. species, the *C. clavipes*, Fab.; *Catogenus*, Westw., one, the *C. rufus*, Fab.; *Lœmophlœus*, Lap., ten species; *Brontes*, Fab., three species; and *Silvanus*, Latr., nine species.

The word *Cucujus* comes from the Brazilian Cucuyo and Spanish Cucujo, a name given by the natives to the luminous snapping-beetle (*Elater noctilucus*, Linn.) of South America.

Family XXI. COLYDIIDÆ.

This family includes two principal types. In one, forming the sub-family Colydiides, the species are elongate and cylindrical, with ribbed or striate elytra, and in the other, or the sub-family of Synchitides, the species are simply oval or oblong, somewhat flattened, and remarkable for their rough or spinous bodies. The antennæ are either moderately and gradually clavate, or terminate in a small club, which usually includes but two joints. The tarsi are all strictly four-jointed. These insects have the same carnivorous habits which seem to be common to most of the species included in our division of sub-clavicornes. The larvæ of *Ditoma*, of *Aulonium*, and of *Cerylon*, have all been seen depredating upon the larvæ of Tomicus and other small wood-boring beetles, and one species, at least, the *Cerylon histeroides*, is equally predaceous in its perfect state.

Forty-four N. A. species have been described.

Family XXII. LATHRIDIIDÆ.

Very small and not very common insects, sometimes found under stones and sometimes caught flying. They are of an oblong form, the abdomen being wider than the thorax. The antennæ terminate in a small club of one, two, or three joints. The tarsi are three-jointed, the last joint being at least as long as the other two. The thorax has a raised border, and the elytra are puncto-striate, and ribbed between the striæ.

About fifty N. A. species have been described.

Third Sub-section, MONILICORNES.

Antennæ often moniliform or bead-like; subsist mostly upon decaying vegetable substances.

TRIBE V.
SHORT WINGED SCAVENGER-BEETLES.

Putrivora brevipennata. BRACHELYTRA, Latreille.

This tribe embraces an extensive series of beetles, corresponding, for the most part, to the Linnæan genus *Staphylinus*, sometimes called in English *Rove-beetles*, and readily distinguished from all other Coleoptera

by their very short wing-cases, which usually cover less than half of the abdomen. The insects of some other families, as we have seen, have their elytra shortened or *truncated* at the end, but in these they always cover more than half of the abdomen, and usually leave only the tip exposed. The Staphylini have narrow, elongated and somewhat flattened bodies. The antennæ are rather short, sometimes of equal thickness throughout, but usually a little larger at the end, and composed of short, roundish or lenticular joints. The mandibles are long, sharp and sickle-shaped, and usually cross each other at the tip when at rest. The abdomen often terminates in two little finger-like bristly processes, between which is a third and shorter one. The anterior tarsi of the males are often dilated. They are also distinguished by the great length of the coxæ or basal joints of their anterior legs. They usually turn up the end of their long flexible abdomen whilst running, and also use it in packing their wings under their short wing-covers. These insects are generally found on the ground, under stones and amongst rubbish. They usually subsist upon decomposing matter, both animal and vegetable, but mostly the latter. They constitute an extensive army of useful scavengers, second in number only to the Necrophaga or club-horned scavengers, of which we have just been treating. But some of the larger species are known to be eminently predaceous, especially in the larva state, voraciously seizing whatever insects come in their way, not even sparing their own species, and some of the small species found on flowers have been observed to have similarly carnivorous tastes. Indeed, their long, sharp, sickle-shaped mandibles, and the large protuberant eyes of a portion of them, would seem to indicate a more generally carnivorous habit than has generally been attributed to them. Others have been found in ants' nests, and are supposed to be parasitic; and a species of Aleochara is an internal parasite, having been reared from the pupæ of *Anthomyia brassicæ*. (Am. Ent. 11, 370.) The larvæ, with the exception of the absence of wings, bear a general resemblance to the perfect insects, both in structure and habits, and are found in the same situations.

The tribe is composed of two families, the long bodied species or Staphylinidæ, and the minute short bodied species, which constitute the family of Pselaphidæ.

Family XXIII. STAPHYLINIDÆ.

The original meaning and application of the generic term Staphylinus are not now known with certainty, but it was applied by Linnæus to the tribe of short-winged Coleoptera. The leading characters of this family have been given in treating of the tribe to which it belongs, and of which it constitutes much the larger part. We will here define the

principal sections or sub-families into which it has been divided. Modern authors divide the family into eleven sub-families, but seven of these contain all but a few rare or exotic species.

The following table exhibits the most conspicuous of their distinctive characters:

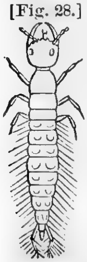
A. Body narrow and elongated. Elytra (except in the Tachyporides) covering less than half of the abdomen. No ocelli.
- B. Head as wide, at least, as the thorax, and usually attached to it by a short neck.
  - C. Labrum bilobed. Antennæ inserted upon the anterior edge of the front. Size often large ....STAPHYLINIDES.
  - C C. Labrum usually entire. Antennæ inserted at the sides of the front. Size moderate or small.
    - D. Maxillary palpi short. Posterior coxæ wide. Tibæ usually spinous on the outer edge. Tarsi usually three-jointed. Abdomen parallel. OXYTELIDES.
    - D D. Maxillary palpi long and clavate. Posterior coxæ much longer than wide. Tarsi usually five, sometimes four-jointed. Abdomen more or less tapering.
      - E. Anterior coxæ large. Eyes not prominent ....PEDERIDES.
      - E E. Anterior coxæ small. Eyes large and prominent ....STENIDES.
- B B. Head narrower than the thorax, and more or less inserted in it, often imperfectly visible from above.
  - F. Body depressed, of equal width and obtuse. Elytra usually covering a third or less of the abdomen ....................ALEOCHARIDES.
  - F F. Body convex, conical and pointed behind. Elytra sometimes covering half or more than half of the abdomen .....TACHYPORIDES.

A A. Body broad and depressed. Elytra usually covering half or more than half of the abdomen. Two ocelli on the vertex. Size small...........OMALIIDES.

Sub-family STAPYLINIDES.

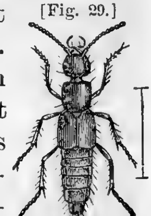
This group stands at the head of the family containing all the large species, sometimes exceeding an inch in length, though some of the genera also contain small species. Its two most distinctive characters are those given in the table. The antennæ are inserted upon the epistoma, which is the ridge which borders the face below, just above the mouth. In the other groups of this family the antennæ are inserted above the epistoma, at the sides of the face, and are usually covered at the base by a little prominence. The species are usually found amongst rubbish, or under dead leaves or stones. They have been supposed to be mostly rypophagous, but some of them are known to be eminently predaceous.

[Fig. 28.]



Larva of GOERIUS OLENS:—after Westwood.

[Fig. 29.]



PHILONTHUS APICALIS, Say:—after Riley.

More than a hundred N. A. species have been described.

A. Antennæ inserted wide apart, at the extremities of the epistoma.
  B. Palpi not enlarged at tip.
    C. Size large, from half an inch to an inch or more in length. Surface pubescent, (except ocypus)
      D. Head of males large, wider than thorax; middle coxæ wide apart.
        E. Antennæ sub-clavate; abdomen as wide as elytra.......................... CREOPHYLUS.
        E E. Antennæ filiform; abdomen narrower than elytra.......................... LEISTOTROPHUS.
      D D. Head of males not enlarged; middle coxæ approximate.
        F. Form slightly tapering; brown or dull black.......................... STAPHYLINUS.
        F F. Form elongate, parallel; shining black.......................... OCYPUS.
    C C. Size small, usually less than half an inch in length; shining black, sometimes tinted with red.......................... PHILONTHUS.
  B B. Labial palpi terminated with a large semilunar joint; head of males enlarged; middle coxæ very wide apart. Size below medium; glabrous.......................... OXYPORUS.
A A. Antennæ approximate, inserted on the middle of the epistoma; head oblong, sub-quadrate. Length usually a quarter of an inch or less, elytra often reddish.......................... XANTHOLINUS.

Creophilus, Stephens, contains two N. A. species, one of which, the *C. villosus*, Grav., is not uncommon. It is a robust species, about seven-tenths of an inch long, black, with a broad ash-colored band across the elytra, and another across the abdomen, composed of short hairs. The specific name *villosus—hairy*, is expressive of this character. The generic name means a *lover of flesh*. *Leistotrophus*, Perty, a name expressive of the ferocious character of the species, contains but one N. A. species, *L. cingulatus*, Grav. It is of about the same size as the preceding, of a grayish-brown color, indistinctly spotted with black. The end of the abdomen has a golden luster. Twenty-one species of *Staphylinus* proper are enumerated in Dr. LeConte's catalogue of 1863. One of the largest and most common species is the *S. maculosus*, Grav., eight or nine-tenths of an inch long, of a dark cinnamon-brown color, with a black scutellum, and a row of obscure square blackish spots along the middle of the abdomen. A somewhat similar but rarer and more elegant species is the *S. vulpinus* or *fox-colored* Staphylinus of Nordman. In this the colors are brighter, and the abdomen is black, tipped with fulvous, with golden incissions, and two cinereous pubescent spots at the base of each segment. The *S. cinnamopterus*, Grav., is also cinnamon-colored, with the abdomen nearly black; but it is a smaller species, being but half an inch, or a little more, in length. *S. tomentosus*, Grav., is six-tenths of an inch long, and of a deep, dull black color. *S. violaceous* is of about the same size, also black, but with the thorax and elytra of a rich violet hue. The abdomen is varied along the margin with a silken ash-colored pubescence.

Ocypus, Kirby, meaning *swift-footed*, contains but one species, the *O. ater*, Erichs., seven-tenths of an inch long. *Philonthus*, Curtis, meaning a *lover of dung*, contains many species, a few of which exceed half an inch in length; but most of them range from two to three-tenths of an inch. A considerable number of our species are arranged under the genus *Quedius*, of Stephens, which is closely allied to Philonthus, but differs in having the thorax with a sharp simple margin, and a fe

large scattered punctures, whilst in Philonthus the thorax is finely grooved along the edge, and the punctures, also large and few, are arranged in longitudinal rows. The genus *Oxyporus*, Fab., occupies an intermediate position between this sub-family and the Oxytelides, and is placed in the latter by some authors; but Lacordaire retains it in the present sub-family, the essential characters of which it possesses. The species are not large, but they are unusually broad and robust, and are most readily distinguished by their stout mandibles, which project directly forward, and are crossed at the tip when at rest. The species vary from a quarter to nearly a half an inch in length. They are found in fungi upon trees. *O. rufipennis*, Lec., varies from less than three to more than four-tenths of an inch in length, glossy black, with light reddish-yellow elytra, slightly tipped with black at their outer angles. *O. femoralis*, Grav., between three and four-tenths of an inch; black or brown, with pale dull flaxen-yellow elytra, more broadly tipped with black at the outer angles. *O. vittatus*, Grav., very much like the last, but smaller. *O. 5-maculatus* (Melsh.) Lec., between three and four-tenths of an inch; bright tawny-yellow, with black spots, as follows: one on the vertex, one on each side of the thorax, one covering the outer angle of each elytron, and one on the top of each abdominal segment, the two posterior of which are widened into bands. The females are almost wholly yellow, but the outer angles of the elytra are always black. *O. stygicus*, Say, three-tenths of an inch, body wholly black, labrum, base of antennæ, and tarsi reddish. Two other species, the *major* and the *lateralis*, Grav., I have not seen. *Xantholinus*, Serv., the name indicating the reddish-yellow color of most of the species, contains a moderate number of species, which do not vary much from a quarter of an inch in length. In color and general aspect they are liable to be confounded with some of the species of Cryptobium and Lathrobium, in the sub-family of Pederides; but we shall point out the distinctions when we come to speak of those genera.

Sub-family OXYTELIDES.

A small group founded upon the genus *Oxytelus*, Grav. Their most distinctive character is the row of spines on the outer edge of the anterior, and sometimes also the middle tibiæ. Their antennæ are slightly thickened toward the tip, and the abdomen is parallel and usually obtuse or rounded at the end, but with the terminal segment abruptly narrowed, forming a small point, to which the name *Oxytelus*, meaning a *pointed end*, probably refers. These two characters also serve to distinguish them from most of the Staphylinidæ, except the Aleocharides, and from these they are distinguished by their free heads, which are as wide as the thorax. But their most abnormal character is their usually

three-jointed tarsi, the last joint being as long as the others united. The species are all small, rarely exceeeding a quarter of an inch in length, and sometimes being less than a tenth. The spines or teeth on their anterior tibiæ indicate their fossorial habits, and accordingly they are usually found burrowing into manure or under the bark of decayed trees. Mr. Westwood refers to a species of Bledius which is sometimes found in great profusion, burrowing into the sand on the sea shore below high water mark, and where consequently they must often be submerged by the tide.

Most of our species, upwards of forty in number, are included in the three following genera; the first of which, however, contains but a single species:

A. Abdomen without a margin; tarsi five jointed. Size rather large........................Osorious.
A A. Abdomen margined; tarsi three jointed; size small.
  B. Anterior tibiæ with two rows of spines; body cylindrical........................Bledius.
  B B. Anterior tibiæ with one row of spines; body depressed........................Oxytelus.

Sub-family PEDERIDES.

The species of this group are distinguished by their long clavate palpi, the last joint but one being larger than the others, but the last joint of all being small and contracted. As a general rule the species are more elongated and slender than in the other sub-families, and their colors are more various. Their length varies from a half to less than a quarter of an inch. They are found mostly in wet places, and are very rapid in their motions. Upwards of sixty N. A. species have been described. The following are the principal genera:

A. Antennæ strongly geniculate, and bristly; size rather large; color black, often strongly tinted with red........................Cryptobium.
A A. Antennæ not geniculate.
  B. Head attached to thorax by a neck of ordinary width; size moderate.
    C. Tarsi simple; color black, sometimes slightly tinted with red........................Lathrobium.
    C C. Penultimate joint of tarsi slightly bilobed; orange red, with head and tip of abdomen black; elytra blue........................Pæderus.
  B B. Head attached by a very narrow neck, (except Palaminus); size small, length less than a quarter of an inch.
    D. Body of ordinary form, color blackish.
      E. Head square behind........................Lithocharis.
      E E. Head narrowed behind........................Stilicus.
    D D. Body very elongate and slender; color wholly or partly yellow.
      F. Head oblong, obtuse, horizontal, pedunculate........................Sunius.
      F F. Head short, transverse, sessile........................Palaminus.

The names *Cryptobium* and *Lathrobium* are expressive of the *concealed* modes of *life* of these insects under stones or dead leaves, or similar situations. The species of the former genus are usually more, and those of the latter less, than a third of an inch in length; but this rule has a few exceptions. The *C. pusillum*, Lec., is but two-tenths of an inch long, and on the other hand the *L. grande* is four-tenths.

Cryptobium, Mann., is most readily recognized by its strongly geniculate or elbowed antennæ, the first joint being nearly as long as the three following ones united. This character, together with their oblong heads, and reddish coloration, give them a resemblance, as we have above remarked, to Xantholinus, in a former section; and this affinity is increased by the bilobed labrum which occurs exceptionally in this and the following genus. But in Cryptobium the species are usually larger, and the antennæ longer and more strongly elbowed, in addition to the clavate palpi. *Pæderus*, Grav., is at once recognized by the variegated colors as stated in the table. The species are few in number, but one of them, the *P. littorarius*, Grav., is common and widely distributed, being usually found under stones in wet places. The other genera have but three or four known species each. *Stilicus*, Latr., is distinguished by its head narrowed behind, and the ovoid thorax narrowed in front, so that the two parts are united by a mere point, giving to them the aspect of small ants. *Palaminus testaceus*, Erichs., not quite two-tenths of an inch in length, and of a pale yellow color, is not uncommon. They attract attention by their very slender shape and their vermicular or snake-like motions.

Sub-family STENIDES.

This sub-family is composed almost wholly of the genus *Stenus* of Latreille, a word meaning *narrow*, and expressive of their slender form. The species are less than a quarter of an inch in length, of a grayish-black color, and are at once distinguished from all other Staphylinidæ by their large portuberant eyes, which cause the head to be considerably wider than the thorax. The antennæ are small and widened at the tips; the maxillary palpi long and club-shaped, with their first joint unusually elongated; and the ligula or tongue is capable of being remarkably extended. The species are usually found running on mud, or in other wet situations. About two dozen species are enumerated in Dr. Leconte's catalogue—closely resembling each other and distinguished chiefly by the sculpture of the surface. The *S. colon*, Say, is distinguished by a yellow semilunar spot on the middle of each elytron.

Sub-family ALEOCHARIDES.

This sub-family contains a numerous assemblage of small, or very small species, rarely attaining a quarter of an inch in length, and often being less than half that length, and ordinarily of obscure black or brownish colors. Their distinguishing characters are sufficiently stated in the table under the letters B B and F. The antennæ are short, rather robust, usually a little thickened at the end, and are inserted upon the front at the inner margin of the eyes. Their habits are various, some being found under stones or fallen leaves, some in the fungi on trees,

and a remarkably large proportion of them in ants' nests. The habit of raising the end of the abdomen whilst running, which is sometimes practiced by the larger Staphylini, is almost universal in this sub-family. A compilation of the descriptions of all the known North American species of this group, amounting to eighty-one in number, is published by Mr. James H. B. Bland, in the fourth volume of the Proc. of the Ent. Soc. of Philadelphia. They are arranged in seventeen genera, many of which contain but one, two, or three species. The following six genera contain a very large proportion of them:

A. Head as wide as the thorax and attached to it by a distinct neck.......................... FALAGRIA.
A A. Head narrower than thorax and partly immersed in it.
B. Thorax widely hollowed in front for the reception of the head. Antennæ filiform and longer than to the end of the elytra.. ATEMELES.
B B. Thorax not hollowed in front. Antennæ not nearly reaching the end of the elytra.
C. All the tarsi five jointed; labial palpi four jointed; length an eighth of an inch or more: ALEOCHARA.
C C. Anterior tarsi four jointed, the others five jointed; length an eighth of an inch or less.
D. Labial palpi three jointed; eyes depressed, finely granulated. Color black, or black and brown.
E. Antennæ slender; abdomen narrowed in front.................................... TACHYUSA.
E E. Antennæ robust; abdomen not narrowed.. HOMALOTA.
D D. Labial palpi two jointed; eyes large, convex, coarsely granulated; color black and light yellow.. GYROPHÆNA.

The anomalous little genus *Falagria*, Mann, is placed in this sub-family by systematists on account of the position of the antennæ, and the exposed prothoracic spiracle, though it departs widely from it by its large pedunculated head. They are only about a tenth of an inch long, and of a reddish black color. *Atemeles*, Stephens, is of much larger size and still more anomalous, and indeed bears no resemblance to the family of Staphylinidæ except in its shortened wing covers. One North American and three European species are all that are known. They inhabit ants' nests. Our species the *A. cava*, Lec., is nearly a quarter of an inch long, and one-third part as broad, and wholly of a rust-red color. *Aleochara*, Grav., contains a few comparatively large species, being usually nearly or quite two-tenths of an inch in length and of a broad oval form. *Homalota*, Mann, contains a great number of small obscure species, being mostly black, with the elytra often tinted with reddish brown. The little genus *Gyrophæna*, Mann, contains six described N. A. species, none of which exceed one line or one-twelfth of an inch in length. The most common species are light yellow, with the head, a part of the elytra, and the tip of the abdomen black; but some minute species are black varied with reddish-brown. The name *Gyrophæna* comes from the Greek *guros—a circle*, and *phaino*—to *appear* or *resemble*, and alludes to the habits of these little insects of carrying their abdomens forwards on their backs, and at the same time bending their heads under their breasts, so as to resemble a little ball.

Sub-family TACHYPORIDES.

In addition to the characters given in the table, we may add that the tibiæ are strongly beset with spines, which distinguishes them not only from the Aleocharides but from nearly all the species in the other sub-families except the Oxytelides. The abdomen also is often bordered and terminated with divergent spines. The antennæ are inserted under the sides of the face, behind the mandibles, and are generally slightly thickened towards the tip. They are considerably numerous, fifty-seven N. A. species having been described. A few of them are of medium size, but the great majority are considerably less than a quarter of an inch in length. They are usually shining black, with the elytra often tinted with dark red, rarely inclining to yellow, but this is a style of coloration which is very prevalent in the whole family of Staphylinidæ. It has been observed that the species of this sub-family never turn their abdomens upwards, as is so generally done by the Aleocharides and some other Staphylinidæ. They inhabit fungi, boleti, dung and other decayed matter. Some are found under dead bark. The following table exhibits the principal genera into which this group has been divided:

A. Antennæ eleven jointed; tarsi five jointed; size various.
  B. Elytra longer than the thorax, minutely and irregularly punctured.
    C. Abdomen with a narrow margin; surface glabrous.
      D. Body oblong, somewhat depressed, moderately tapering, maxillary palpi filiform; length from one-eighth to more than a quarter of an inch .... TACHINUS.
      D D. Body short, convex, abruptly tapering; maxillary palpi sometimes swollen, subulate or pointed at the end; length less than an eighth of an inch .... TACHYPORUS.
    C C. Abdomen without a margin; surface finely pubescent, form conical, size small ... CONOSOMA.
  B B. Elytra about as long as thorax; smooth or with three rows of punctures.
      E. Maxillary palpi filiform; length from an eighth to more than a third of an inch: BOLETOBIUS.
      E E. Maxillary palpi swollen, subulate at tip, size small .... MYCETOPORUS.
A A. Antennæ ten jointed; tarsi four jointed; size extremely small .... HYPOCYPTUS

Tachinus, Grav., meaning *swift*, and *Boletobius*, Leach, meaning *living* in *boleti*, contain, as seen by the table, all the larger species, but they vary much in size. *Conosoma*, Kraatz, contains but three species, about a tenth of an inch or a little more in length. They resemble Tachyporus in the convex conical shape of the body, but they are finely pubescent or silky on the surface, and the abdomen is rounded at the sides, without the narrow sharp margin which is common to all the other genera. *Mycetoporus*, Mann, is very closely allied to Boletobius, but the species are usually smaller, and more linear in their form. The names of the two genera mean essentially the same thing. *Hypocyptus*, Schup., contains the smallest species in the family of Staphylinidæ, and some of the smallest in the order of Coleoptera, or in the class of insects, being about the twenty-fifth of an inch in length, and some of them not more than a fiftieth. The generic name is derived from the Greek *hupo*—

under, and *kuptos—bent*, in allusion to their habit of bending the head under the body, which, together with their convex form, gives them the appearance of little globes or balls, much like the genus Agathidium referred to above in the family Anisotomidæ, and also like Gyrophæna in the preceding sub-family of Aleocharides, but in the last the effect is produced in a different manner. The genus *Coproporus*, Kraatz, does not seem to be sufficiently distinct from Tachyporus, nor *Byroporus* from Boletobius, to render the formation of these genera necessary.

Sub-family OMALIIDES.

Founded upon the genus *Omalium*, Grav., from the Greek *omalos—level*, on account of the comparatively broad and depressed form of most of the species. Their most essential character is the presence of two ocelli, resembling minute glass beads, on the back part of their heads—a character peculiar to this sub-family, with but two or three known exceptions. But their most conspicuous character is the comparatively greater length of the elytra, which also has a few exceptions. The large depressed elytra give to some of these insects an obvious resemblance to the Nitidulæ, in the preceding tribe; but in these only the tip of the abdomen is usually exposed, and their knobbed antennæ at once distinguish them from any of the Staphylinidæ. The species of the present sub-family are of obscure brown or yellowish colors, and small size, never attaining a quarter of an inch in length, and often being less than an eighth. Their habits are various, some being found in wet places, under stones, or under decayed bark, whilst others are found on plants and flowers, and Mr. Walsh bred some of them from fungi.

Upwards of fifty N. A. species have been described, most of which are contained in the following genera:

A. Mandibles toothed; head entirely free; thorax heart-shaped, narrow behind.
- B. Last joint of palpi three times as long as the preceding.......LESTEVA.
- B B. Last joint of palpi not elongated.......ANTHOPHAGUS.

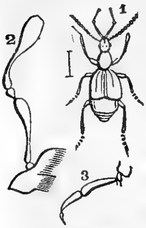
A A. Mandibles simple; head partly inserted; thorax not narrowed behind.
- C. Hind tarsi moderately elongated; elytra covering the greater part of the abdomen; tibæ not spinous.......OLOPHRUM.
- C C. Hind tarsi short, the four first joints combined not longer than the fifth.
  - D. Tibiæ finally spinous; elytra covering about half of abdomen.......OMALIUM.
  - D D. Tibiæ not spinous; elytra almost or quite covering abdomen.......ANTHOBIUM.

Anthophagus, Grav., scarcely differs generically from *Lesteva*, Latr.; but their habits are different—the former being found on flowers, and the latter amongst wet herbage, near the water. They are easily distinguished from all other Staphylinidæ by the heart-shaped thorax, which, together with the free head and prominent eyes, gives them a remarkable resemblance to some of the smaller Carabidæ. There is a small yellowish species in the Walsh cabinet, labeled "*Anthobium protectum*, LeC., from Mass.," in which the abdomen is completely covered by the elytra.

Family XXIV. PSELAPHIDÆ.

This is a family of minute beetles, generally less than a tenth of an inch in length, and is founded upon the genus Pselaphus, of Herbst, a term derived from the Greek *pselaphus—to feel*, in allusion to the greatly developed palpi or feelers. They are found in the same situations as the Staphylinidæ, and resemble them in the shortness of the elytra, which usually cover only about half of the abdomen. In their form, however, they are wholly different, being short thick-bodied beetles, with the abdomen much larger than the thorax. The antennæ are clavate or capitate, and the maxillary palpi are very long and clavate, often equalling the antennæ in length. The tarsi are apparently two-jointed, but really three-jointed, the first joint being very small. Like some of the larger Staphylinidæ, these very small insects are predaceous in their habits, subsisting upon acari and other minute animals. Some of them are found in ants' nests. A synopsis of the Pselaphidæ of the United States is given by Dr. E. Brendel, in the sixth volume of the Proceedings of the Ent. Soc. of Philadelphia, where eighty species are briefly described.

[Fig. 30.]



PSELAPHUS:—1, beetle; 2, maxillary palpus; 3, tarsus, showing minute basal articulation, all magnified—after Westw.

Fourth Sub-section. PECTINICORNES.

Antennæ pectinate or comb-toothed; subsist mostly upon the sap of trees.

TRIBE VI.

STAG-BEETLES.

This sub-division and tribe are composed of the single family of Lucanidæ or Stag-beetles, distinguished by their pectinate or comb-toothed antennæ, which are also strongly geniculate or elbowed; by the projecting mandibles, which, in the males, are often enormously developed and branched, from which these insects have received their common name of Stag-beetles; and by their size, which is never below the medium, and is generally large or very large, some species being upwards of two inches in length, including the mandibles.

These insects are closely allied to the Lamellicorn beetles which follow, and are considered by many authors as holding the rank of only a sub-division or family of the latter. Most modern authors, however, treat them separately. The principal differences may be expressed as follows:

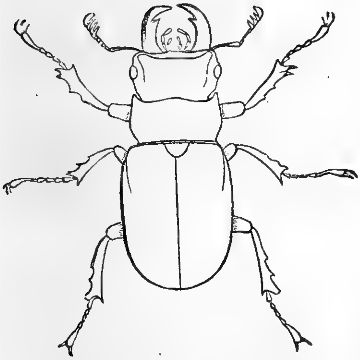
Pectinicornes. Antennæ elbowed, the club composed of fixed transverse teeth. Mandibles of the males often greatly developed. The nervous ganglia distributed through the abdomen as well as the thorax. Larvæ without transverse wrinkles upon the segments; anal opening lengthwise.

Lamellicornes. Antennæ not elbowed, the club composed of moveable plates. Mandibles of the males not remarkably developed. Nervous ganglia consolidated in the thorax. Larvæ with transverse wrinkles upon the segments. Anal opening crosswise, except in the sub-family of Passalides.

We have the more readily adopted this separate classification of these insects as it enables us to discard the discordant element of Lucanidæ from the otherwise comparatively homogeneous group of lamellicorn beetles, with neither of the two great tribes of which can they be made to harmonize.

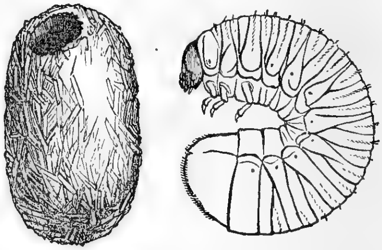
Family XXV. LUCANIDÆ.

[Fig. 31.]



LUCANUS DAMA, Fabr. :—after Packard.

[Fig. 32.]



LUCANAS DAMA, Fabr. :—larvæ and cocoon–after Pack'

The characters of this family have been given above sufficiently for their recognition. Notwithstanding their conspicuous size, but little is known of the habits of the perfect insects. The few observations on record go to show that their ordinary food consists of honey dew, or the exudations of the leaves and bark of trees, which last they are said to pierce with their pincer-like mandibles, but the force with which these organs are brought together does not seem to be sufficient for this purpose. They have been known to feed readily, in confinement, upon moistened sugar. The larvæ are found in rotton wood, and some of them have been known to bore into the solid roots of trees. But in this country they have never been known to be seriously injurious.

A. Ligula elongated and attached to the anterior face of the mentum; antennæ usually elbowed; first joint nearly or quite as long as all the others united; abdomen moderately pedunculated; scutellum normal and distinct.

B. Body moderately convex; head unarmed, and in the males nearly or quite as wide as the thorax; club of antennæ 4-jointed with the first joint small.

C. Antennæ geniculate or elbowed; anterior coxæ approximate.

D. Mandibles pointed; eyes notched by the margin of the head.

E. Elytra smooth, slightly curved at the sides; size very large...LUCANUS.

E E. Elytra striate and punctate; sides parallel; size above medium. DORCUS.

D D. Mandibles thickened, obtuse, and many toothed at the end; eyes scarcely notched; size medium..................................PLATYCERUS.

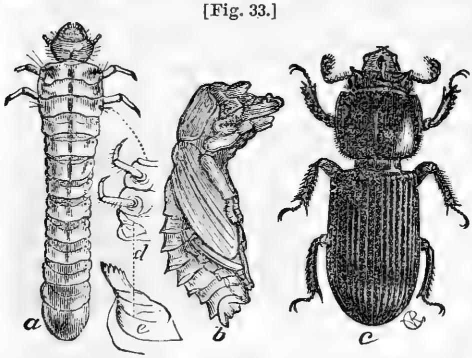
C C. Antennæ not geniculate; anterior coxæ contiguous; size medium. CERUCHUS.

B B. Body cylindrical; head much narrower than the thorax, and prolonged into a horn in the male, and tubercled in the female; size medium. SINODENDRON.

A A. Ligula broad, and filling the quadrangular notch of the mentum; antennæ not elbowed, first joint moderate; scutellum broad but indistinct, situated on the peduncle; elytra parallel and deeply furrowed. Size very large. PASSALUS.

Lucanus contains three N. American species; the *L. elaphus*, a Southern species, the male varying in length from one and a half to more than two inches, with large branching mandibles, larger than the head and thorax; *L. dama*, our common *pinching beetle*, of a mahogany-brown color, and from an inch to an inch and a half long; and the *L. placidus*, an inch long, almost black, with the tooth of the mandibles bifid at the tip. *Dorcus* has but one generally known species, the *parallelus*, of Say, brownish-black, and eight or nine-tenths of an inch in length. The *Platycerus quercus*, four-tenths of an inch long, of a brownish-black color, is a widely distributed, but nowhere a common species. *Ceruchus piceus*, dark brown, and half an inch long, is occasionally found in considerable numbers in rotten wood. *Sinodendron* is not known east of the Rocky Mountains. *Passalus cornutus*, a large, oblong, depressed beetle, an inch and a quarter long, of a shining black color, sometimes with a dark-reddish tint, and with a short horn bent forwards, on the top of the head, is not an uncommon insect about the roots of decayed stumps and other similar situations. The genus Passalus contains many species, most of which inhabit S. America, but the *P. cornutus* is the only species found in the United States.

[Fig. 33.]



PASSALUS CORNUTUS:—*a*, larva; *b*, pupa; *c*, beetle; *d*, underside of thoracic joints, showing atrophied hind leg of larva; *e*, same enlarged—after Riley.

Meaning of generic terms:

Lucanus—the stag, alluding to the large branching mandibles of some of the males.

Dorcus—the antelope. The males of some foreign species have large toothed mandibles.

Platycerus—having *wide antennæ.*

Ceruchus—bearing a horn.

Sinodendron—injuring trees.

Passalus—a post or peg, referring to the horn on the head of some species.

Fifth Sub-section, LAMELLICORNES.

Antennæ lamellate. Habits of the two tribes different.

This is the extensive and natural group of Coleopterous insects, generally known by their scientific name of Lamellicornes, or Lamellicorn-beetles, and so called from the peculiar construction of their antennæ, which terminate in a club formed of moveable plates or leaves, which, with a few exceptions, are three in number. In some of the insects of the Clavicorn division, the club of the antenna is also composed of thin flat joints, constituting what is known as the perfoliate antenna, but here the axis of the antenna passes through the plates, which are immovable; but in the lamellate antenna, the plates are attached to the axis by only one of their sides, which leaves them free to open and shut like the leaves of a book. These plates are sometimes thin and similar; sometimes the first is thick and hollowed out to receive the other two, and sometimes the two outer ones are thickened and enclose the intermediate one. In the dead specimen these plates are generally closed together. One of the most conspicuous and invariable characters of the family is the form of the anterior tibiæ which are constructed for digging in the ground, being broad and compressed, and strongly toothed and scalloped on their outer edge.

The larvæ are white, six-footed grubs, some of which are found in manure and others in rotten wood. A few of the larger species have been seriously injurious, both in Europe and in this country, by feeding upon the roots of grasses and other plants. They are usually seen lying upon one side in a curved position. They are gross feeders, and the hinder part of their bodies is usually filled with black excrementitious matter, which is partially visible through the semi-transparent walls of the abdomen.

The common *white grub*, which is the larva of the May-beetle, is a familiar example of these larvæ.

With respect to their food habits these insects are divided into two large, somewhat equal, and well marked tribes. They were all included by Linnæus in his genus Scarabæus.

Tribe 1st (or 7th of the whole series), *Excrementivora.* Elytra (except in the first family), covering the whole of the abdomen. Legs stout, the hind legs set far back, behind the middle of the hind-body. Live upon putrescent or decomposing matters, chiefly the excrement of animals.

Families: Copridæ, Aphodiidæ, Geotrupidæ and Trogidæ.

Tribe 2d (or 8th), *Herbivora.* Tip of the abdomen always exposed. Legs (except in the Dynastidæ) rather slender, and with the hind legs attached at or before the middle of the hind body. Live upon fresh vegetable food, either leaves or flowers.

Families: Dynastidæ, Rutelidæ, Melolonthidæ and Cetoniidæ.

TRIBE VII.

LAMELLICORN DUNG-BEETLES.

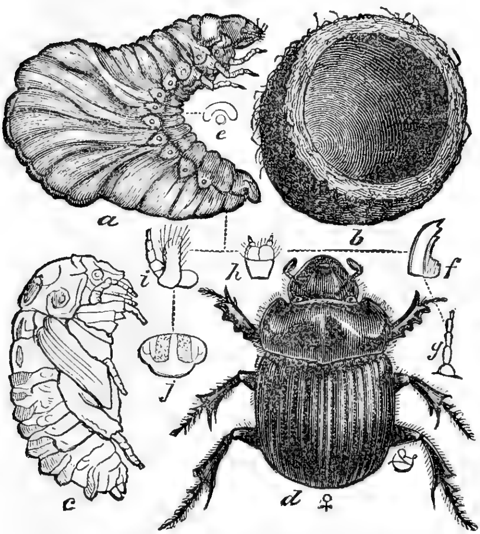
Excrementivora lamellicornia. SAPROPHAGA, MacLeay.

These beetles, as their name implies, are found almost exclusively in the dung of animals, mostly that of horses and cows, upon which they feed, and the decomposition of which they hasten, and thus constitute an important wing of the great army of useful insect scavengers. The tribe is composed of the four following families:

A. End of the abdomen exposed. Middle legs wider apart than the others; hind tibiæ with a single spur; antennæ 8 or 9-jointed; size various......COPRIDÆ.
A A. Abdomen wholly covered by elytra. Middle legs not wider apart than the others; hind tibiæ with two spurs; antennæ 9 to 11-jointed.
B. Abdomen with six ventral segments. Anterior thighs not dilated.
C. Antennæ 9-jointed. Body almost cylindrical; size small......APHODIIDÆ.
C C. Antennæ 11-jointed. Mandibles robust and exposed; body oval or rounded; size various..................................GEOTRUPIDÆ.
B B. Abdomen with five ventral segments. Anterior thighs greatly dilated; body rough; size small to medium ... .TROGIDÆ.

Sub-family XXVI. COPRIDÆ.

[Fig. 34.]



COPRIS CAROLINA, Linn.:—*a*, larva; *b*, a section of the hollow excrementitious ball in which the insect undergoes its transformations; *c*, pupa of C. MARGINATUS (from Dehaan); *d*, female beetle; *e*, the spiracle, or breathing pore of larva; *f*, the mandible; *g*, the antenna; *h*, the labium, with the rudimentary labial palpi; *i*, the maxilla and maxillary palpus; *j*, the swelling on the under side of the anal segment—after Riley.

This family contains the largest species in this tribe of Lamellicorns, the *Copris Carolina* being upwards of an inch in length, two-thirds of an inch in width, and half an inch in thickness. But it also contains small species. The *Chæridium capistratum*, a shining, mahogany-brown insect, is scarcely a quarter of an inch in length, and some of the Onthophagi are still smaller. Many of the males have a horn or tubercle on the top of the head. In this division is the common tumble-dung beetle, (*Canthon lævis*, Drury.) A pair of these insects is often seen working in concert, and rolling a ball of manure in search of some suitable place

in which to bury it. Mr. Riley informs me that the common notion that the egg is rolled up in the center of this ball is an erroneous one, and that the egg is in reality deposited in a cavity at one side, made for the purpose after the ball is sunk. The young feed upon the half decomposed matter of which the ball is composed. The species are generally black, but some have rich metallic hues. The *Copris* (*Phanæus*) *carnifex*, with its tints of burnished copper and green, is one of our richest insects.

A. Middle and hind tibiæ slender. Size medium ; color black........................CANTHON, 17 sp.
A A. Middle and hind tibiæ enlarged at the end.
  B. Labial palpi 3-jointed.
    C. Anterior coxæ strongly tranverse and depressed. Size small ; color brown.....CHŒRIDIUM, 3.
    C C. Anterior coxæ large, conical and prominent. Size large or medium ; color black or metallic: COPRIS, 10.
  B B. Labial palpi 2-jointed. Anterior coxæ large and conical ; size small ; color black: ONTHOPHAGUS, 10.

Family XXVII. APHODIIDÆ.

These are small beetles found in great abundance in the fresh manure of horses and cows, into which they burrow almost as soon as dropped from the animals. They never much exceed a quarter of an inch in length, and are usually black, but sometimes with red or brown elytra. Nearly a hundred N. A. species have been described, and divided into a number of sub-genera, but they may all be included in the genus *Aphodius* of Illiger.

[Fig. 35.]

APHODIUS:—1, beetle; 2, antenna—after Westwood.

The following are among our most common species: The *A. fimetarius*, Fab., nearly three-tenths of an inch long; head and thorax shining black, and elytra red; the *A. oblongus*, Say, is equally long, rather more slender, and wholly black; the *A. terminalis* is less than two-tenths of an inch long, black with the tip of the elytra and legs reddish; the *A. serval*, Say, is of the same size, black, with the elytra dirty white, with three sub-quadrate black spots and a lateral double or triple irregular interrupted black stripe on each.

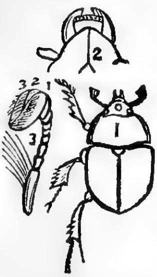
Family XXVIII. GEOTRUPIDÆ.

These are distinguished from the two preceding families by their robust horny mandibles which project visibly beyond the upper lip. Their average size is above medium, but the Bolboceri fall considerably below it. The Geotrupes (more correctly spelled Geotrypes) are very common insects, found under cow-dung in pastures, often burrowing into the ground beneath.

The following are the two principal genera:

A. Club of antennæ small with the plates of equal thickness; size medium or above; color dark metallic green or purple, sometimes black .... GEOTRYPES, 7.
A A. Club of antennæ large and compact with the plates of unequal thickness; size below medium; color brown .... BOLBOCERUS, 3.

[Fig. 36.]



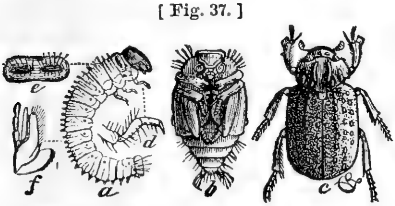
GEOTRUPES: — 1, beetle; 2, mandibles; 3, antenna, showing the large 3-jointed subglobose club, and how the middle joint is encased in the preceding—after Westwood.

The *G. splendidus*, Fab., is our most common species, usually about seven-tenths of an inch long, but varying considerably in size, and varying also in color from dark metallic green to purple. *G. excrementi*, Say, is a little more than five-tenths of an inch in length, and of a bronze-black color. *G. opacus*, Hald., is of a deep black color, and varies in length from a little below to a little above half an inch; it is much rarer than the other two species. The elytra are not furrowed like the others, but only marked with lines of minute punctures. The *Bolbocerus farctus*, Panzer, is half an inch long, brownish-yellow, with the hind margin of the thorax, the sutural line, and the broad tips of the elytra black. *B. Lazarus*, Panzer, is four-tenths of an inch long, and wholly of a mahogany-brown color. *B. filicornis*, Say, three-tenths of an inch long, of the same color as the last, and distinguished by a slender horn on the top of the head of the males, whilst the others have only tubercles. The last species has been separated from the others under the generic name of *Odontæus*. It is also distinguished by having the eyes completely divided by the lateral margins of the head.

Family XXIX. TROGIDÆ.

These insects are readily distinguished by their coarsely pitted thorax and ridged elytra. The other characters given in the foregoing table are also very distinctive. They vary in size from more than a half to less than a quarter of an inch in length, and are of a uniform slate-black, or brownish-black color. Their habits are but little known, but they are usually found in sandy situations, and sometimes upon the carcasses of dead animals. Mr. Riley breeds *Trox pustulatus* (Fig. 37.) from dead chickens. They are comparatively rare insects. They are somewhat numerous in species, but are all included in the genus *Trox* of Fabricius.

[Fig. 37.]



TROX PUSTULATUS, LeC.:—*a*, larva; *b*, pupa; *c*, beetle; *d*, *e*, *f*, leg, cervical plate, and maxilla, with palpi of larva enlarged—after Riley.

The following three species may be taken as representatives of the genus: *Trox porcatus*, Say, nearly half an inch long, the elytra with elevated, interrupted lines, and numerous transverse punctures on the interstitial spaces; *T. terrestris*, not quite quarter of an inch in length, the elytra with raised obtuse lines on which are little fascicles of short hairs; and *T. striatulus*, only three-twentieths of an inch in length, with regular grooves between the ridges on the elytra.

TRIBE VIII.

LEAF-CHAFERS.

Herbivora lamellicornia. THALEROPHAGA, MacLeay.

The Chafers, or leaf-eating lamellicorns, are easily distinguished from the Dung-beetles, by the tips of their abdomens being always uncovered by the wing-cases, by their usually more slender legs, and by their lighter and often variegated colors. As we have seen above that the Cicindelidæ represent the lion and tiger amongst the higher animals, so the present tribe may be regarded as representatives of the ruminating quadrupeds, being, as a general rule, the most bulky of coleopterous insects, and exclusively vegetable feeders.

They generally feed, when in the beetle state, upon the leaves of trees, but many of the smaller species devour the petals and pollen of flowers. The Anomalæ are particularly destructive to the foliage of the grape-vine.

The larvæ are found partly in rotten wood and partly in the earth, where they feed upon the roots of grasses and other plants. The common *white grub* furnishes a familiar example.

Like the preceding tribe, they comprise four families, which can usually be distinguished by their general aspect and coloration, but which exhibit but few distinctive organic characters.

They may be tabulated thus:

A. Head or thorax, or both, almost always armed with one or two horns or tubercles; upper lip concealed beneath the clypeus, which is not separated from the front by a suture. Size generally large, or very large; color often black or blackish: DYNASTIDÆ.

A A. Head and thorax unarmed; labrum often partially visible in front of the clypeus, which is separated from the front by a transverse suture, (except Cetoniidæ.) Size various; color never black, (except in a few Cetoniidæ.)

B. Tarsal claws bifid, (except Hoplia); color usually uniformly brown, sometimes varied with patches of whitish hairs or scales; the rows of abdominal spiracles nearly parallel: MELOLONTHIDÆ.

B B. Tarsal claws simple; abdominal spiracles strongly divergent posteriorly; colors usually beautiful and often variegated.

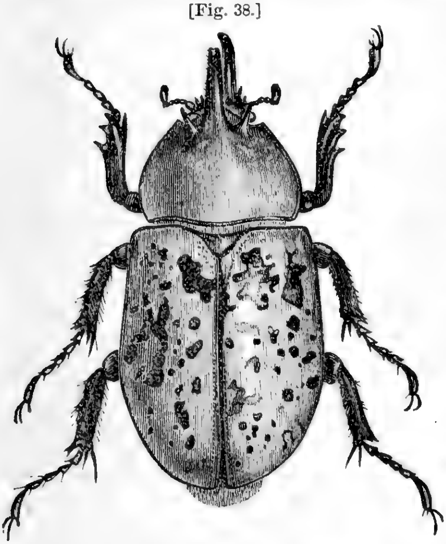
C. Tarsal claws unequal; anterior coxæ transversal and usually depressed; scutellum usually rounded behind: RUTELIDÆ.

C C. Tarsal claws equal; anterior coxæ conical and prominent; scutellum usually triangular and pointed...CETONIIDÆ.

Family XXX. DYNASTIDÆ.

This name has the same origin as the English word *dynasty*, which means *sovereignty*, and it has been given to these beetles on account of their generally large size and imposing aspect. The family contains the largest insects in the order of Coleoptera, some of the tropical species being more than two inches and a half long, and more than an inch in thickness. We have one species in the Southern States, the *Dynastes Tityus*, Linn. (Fig. 38), which is two inches long, of a greenish-gray color, with scattered black spots; there is a long horn on the head and another on the thorax, with a smaller one each side of it; the female has only a tubercle on the head. Another species, the *Xyloryctes satyrus*, Fab., an inch or more in length and of a black color, and with an upright horn on the head of the male, is not uncommon in the Northern and Middle States. Its larvæ are sometimes injurious to ash trees by feeding upon their roots.

[Fig. 38.]



DYNASTES TITYUS, Linn.:—after Riley.

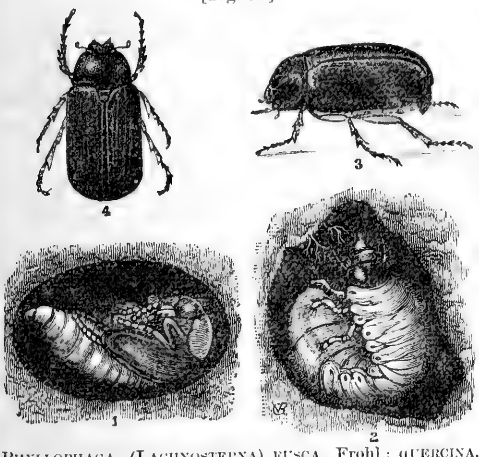
In the genus *Ligyrus*, Burm., the head has two very small tubercles, and the general aspect is much like the common chafers, but they are distinguished at once by their black color. The *L. relictus*, Say, is a very common species. It is three-quarters of an inch long; its larva

is one of the *white grubs*, and is often found in old rotted manure. *Cyclocephala*, Latr., forms a connecting link between this family and the Rutelidæ, all the species being of medium size, of a light-yellowish color, and with the head and thorax wholly unarmed. In its general aspect, therefore, it resembles the latter; but it wants the inequality of the tarsal claws, which is the most distinctive character of the Rutelidæ, whilst the clypeus is almost consolidated with the front, and the labrum is hidden beneath it as in the Dynastidæ.

Family XXXI. MELOLONTHIDÆ.

This is much the most numerous family of Lamellicorns in the North American fauna. They can be easily distinguished, for the most part, by their oblong, somewhat cylindrical form, their uniformly brown color, and by the hooks of the tarsi, which are of equal length, and bifid or forked at the extremity. The genus Melolontha proper, (Polyphylla, Harris,) differs from all our other Lamellicorns in having seven leafets in the club of the antennæ of the males, and five in those of the females, whilst almost all Lamellicorns have but three in both sexes. They also differ from the majority of Melolonthides in being ornamented with spots or stripes which are produced by prostrate white hairs. The species of the genus Hoplia are also variegated with patches of minute white scales; and Macrodactylus, with scales of an ochreous color. The bifid tips of the hooks at the end of the tarsi can be easily seen with a simple lens, and furnish one of the most distinctive characters of this sub-family. The tarsal hooks of Hoplia, however, are anomalous. The hind feet have but a single hook which is generally entire; in the four anterior feet the hooks are double as usual, but unequal, the outer one being larger and bifid at the tips. This genus is also peculiar in having but one spur at the end of the tibiæ. The remarkable genus *Lichnanthe* is regarded by some as forming the type of a distinct sub-family.

[Fig. 39.]



PHYLLOPHAGA (LACHNOSTERNA) FUSCA, Frohl; QUERCINA, Kn.:—1, pupa in its earthen cell; 2, larva; 3, 4, beetle, side and back view—after Riley.

The following table shows the principal N. American genera of Melolonthides, east of the Rocky Mountains:

A. Elytra narrowed and sometimes separate at their tips; tarsal claws equal and simple; whole body, except elytra, covered with long dense hairs........LICHNANTHE, 4.
A A. Elytra not dehiscent; some or all of the tarsal claws bifid; body not conspicuously hairy.
B. Tibiæ with one spur, and hind tarsi with a single entire claw........HOPLIA, 11.
B B. Tibiæ with two spurs; all the tarsi with two bifid claws.
C. Club of antennæ with seven leafets in the male and six in the female; body spotted or striped with short, prostrate, whitish hairs........POLYPHYLLA, 7.
C C. Club of antennæ with 3 leafets; color generally uniform.
D. Claws chelate or capable of being folded down upon the last tarsal joint, minutely cleft at the end, the teeth lying side by side; body parallel and depressed...DICHELONYCHA, 14.
D D. Claws not chelate, strongly bifid, one tooth above the other; body convex.
E. Anterior coxæ not prominent; ventral segments soldered together with their sutures indistinct; medium or large insects, usually more than half an inch in length: PHYLLOPHAGA, 66.
E E. Anterior coxæ elongated and prominent; ventral segments distinct; small species; less than half an inch in length.
F. Body densely clothed with ochreous scales; tarsi very long.....MACRODACTYLUS, 3.
F F. Body usually clothed with a fine silken pubescense; ventral segments six; hind coxæ very broad........SERICA, 16.
F F F. Body naked; glabrous; ventral segments five; hind coxæ normal: DIPLOTAXIS, 39.

Lichnanthe vulpina, Hentz, is a little more than half an inch long, and is at once distinguished by its elytra being narrowed and separated at their ends, and by the body being densely clothed with long rust-yellow hairs. It is quite a rare insect.

The *L. lupina*, LeConte, found on the Atlantic coast, is much smaller than the above, and less densely clothed with cinereous hairs. The elytra in this species do not separate at the tip.

The *Hoplia trifasciata*, Say, is about a third of an inch long, reddish brown, and more or less covered with whitish scales, which are so arranged on the elytra as to form three imperfect transverse bands. *H. modesta*, Hald., is smaller and paler, and the clothing of the elytra resembles hairs more than scales. The other species are more rare, and several of them inhabit California. Two species of Polyphylla are found in the Eastern States: *P. occidentalis*, Linn., in the Southern Atlantic States—often more than an inch in length, with the white down on the elytra arranged in regular stripes; and, *P. variolosa*, Hentz, found in the Middle States, and as far North as Massachusetts—less than an inch in length, and having the elytra irregularly spotted instead of striped. The club of the antennæ is much longer in the males than in the females, a character not peculiar, however, to this genus.

Dichelonycha, Kirby, is composed of a considerable number of small, elongated, depressed species, usually having the elytra more or less tinted with brassy-green, and often requiring a close examination to distinguish one species from another. Our two common species are the *elongata*, Fab., and the *linearis* of Gyllenhal. They differ slightly in

color and in the form of the thorax; but as these characters are variable in both species, it would, perhaps, be more correct to regard them only as varieties.

The genus *Phyllophaga*, Harris, (*Lachnosterna*, Hope,) is very numerous in species, many of which, however, bear a close resemblance to each other. It is emphatically, but not exclusively, a North American genus, 66 of the 116 known species being found in this country. They may be divided into five groups, according to the clothing of the body. In the first and most numerous group, of which the common May-beetle, *P. fusca*, may be taken as the type, the upper side is smooth and shining. The second group contains but one species, the *P. lanceolata*, Say, found mostly west of the Mississippi river, and remarkable for having the body clothed with small lance-shaped cinereous scales. In the third group the body is more or less clothed above with soft erect hairs. Two species of this group are common in some localities, the *P. hirticula*, Knoch, and the *L. Georgicana*, of Gyllenhal. In the former the hairs on the elytra are arranged mostly in three rows, whilst in the latter they are equally distributed. The fourth group contains a small number of large species, in which the whole upper surface is densely clothed with short prostrate hairs or down. The *P. ilicis*, Knoch, is the type of this group. The fifth group is composed of comparatively small species, about half an inch in length, of a pale color, partly smooth above, but with the thorax and base of the elytra densely clothed with long hairs. The *P. tristis*, Fab., the same as the *P. pilosicollis*, Knoch, the type of this group, is not uncommon. One other species is found in Texas. There is also a number of small pale species, half an inch or less in length, with the body glabrous, which might constitute a sixth group. The *P. longitarsis*, Say, is the type of this group, remarkable, as its name implies, for the length of the tarsi.

It must be remarked that all the species of this genus are densely hairy on the under side of the breast, as indicated by the generic term *Lachnosterna*, of Hope.

The common Rose-bug, (*M. subspinosus*, Fab.) is the type of the genus *Macrodactylus*, Latr., a word meaning *long tarsus*. The Rose-bug is between three and a half and four-tenths of an inch in length, covered all over with minute ochre-yellow scale-like hairs, which are not distinctly visible without the aid of a magnifier. The thorax is also somewhat densely clothed with short upright hairs. A specimen from Georgia, with the hairs more conspicuous, has been described by Dr. LeConte under the name *setulosus*. Another species, the *angustatus*, Pal. de Beauv., found in the Southern States, is distinguished by its longer thorax, and the absence of the erect hairs. The genus is exclusively

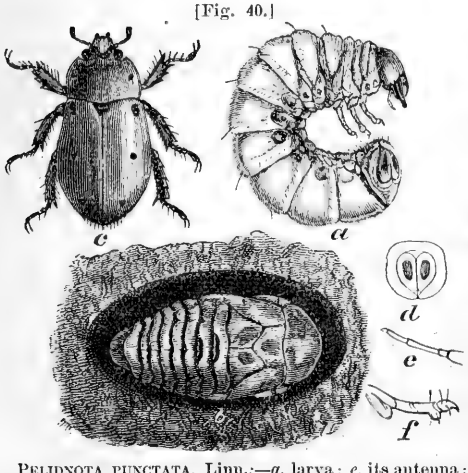
American, but most of the species are found south of the Gulf of Mexico.

The genus Serica is distinguished by the soft silken pubescence with which the body is covered, and which is beautifully iridescent, that is, reflecting the colors of the rainbow. Where this character is deficient, as it is in a few species, they can be readily determined by the remarkable widening of the hind coxæ, which form a broad plate covering the base of the abdomen, and which are at least as wide as any two abdominal segments. The ground color is dark reddish-brown, or almost black. We have three rather common species: the *S. sericea*, Illiger, between three and four tenths of an inch in length, of a dark purple tint; the *S. iricolor*, Say, scarcely three-tenths of an inch long, almost black, and distinguished by the erect hairs with which the thorax is clothed; and the *S. vespertina*, Sch., of the same size as the *sericea*, but destitute of the iridescent pubescence.

Diplotaxis, Kirby, contains a large number of small species, from three to five-tenths of an inch long, and of a reddish brown or black color, and often closely resembling each other. They resemble the genus *serica* in general appearance, but are distinguished by the hind coxæ not being unusually dilated, and the want of pubescence; one species, however, the *sordida*, Say, forms a connecting link, in this respect, by being clothed with erect hairs.

Family XXXII. RUTELIDÆ.

[Fig. 40.]



PELIDNOTA PUNCTATA, Linn.:—*a*, larva; *e*, its antenna; *f*, leg; *d*, tip of abdomen; *b*, pupa, in its cell, the walls of which are composed of particles of wood and excrement; *c*, beetle—after Riley.

The most distinctive characters of the Rutelides are their unequal tarsal claws, and their usually fine or brilliant colors. But our most common species, the Anomalæ, though glabrous, are not brilliant, and might be mistaken for Melolonthæ; but the unequal and uncleft posterior claws readily distinguish them. Most of the insects of this sub-family are tropical. Nineteen N. A. species are known, more than half of which belong to the genus Anomala. This sub-family, like the preceding

one, contains a number of species which are seriously injurious to the horticulturist by devouring the leaves of both ornamental and fruit trees, and especially those of the grape vine.

The table of genera is as follows:

A. Elytra with a very narrow membraneous margin. One of the anterior and middle claws cleft. Size below medium.
  B. Elytra strongly furrowed, with a small notch at base. Thorax impressed, and hairy: STRIGODERMA, 2
  B B. Elytra puncto-striate, and without notch. Thorax plain, and nearly or quite hairless: ANOMALA, 10
A A. Elytra without membrane. Claws all simple. Size above medium.
  C. Clypeus separated from the front by a distinct suture ....COTALPA, 5
  C C. Clypeus not distinct from the front ....PELIDNOTA, 2

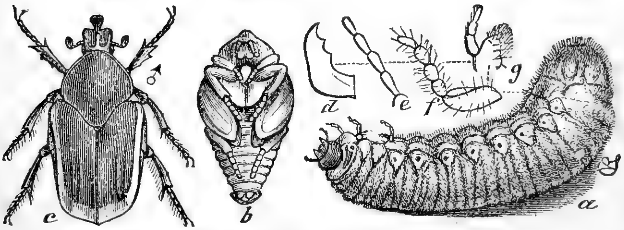
The *Strigoderma arboricola*, Fab., is four-tenths of an inch long; head, disk of thorax, and tip of abdomen blackish; elytra and broad margin of thorax yellowish-brown.

We have two common species of Anomala, the *varians* and the *lucicola*, of Fabricius, which have been much confounded by authors. According to the diagnosis of Burmeister, probably founded, as Dr. LeConte suggests, upon the Fabrician types, the species so common on grape vines at the West, having the elytra faintly striate, and spotted with black so as to form two imperfect bands, and with the mesosternum only slightly carinate, is the true *varians* of Fabricius, whilst the *lucicola* has deeply striate elytra without bands, and the mesosternum strongly protuberant. But the *lucicola* usually has the vertex and disc of the thorax black, and individuals of both species sometimes occur which are wholly black.

The type of the genus Cotalpa is the common goldsmith beetle, *Cotalpa lanigera*, of Linnæus. The *Pelidnota punctata*, Linn., (Fig. 40) is also a large and common species, found feeding upon the leaves of the grape vine. It is nearly an inch long, of a bay color, with three black spots on each wing-cover. Its larva, as Mr. Riley has ascertained, feeds on the decaying roots and stumps of various trees.

Family XXXIII. CETONIIDÆ.

[Fig. 41.]



GYMNETIS (ALLORHINA) NITIDA, Linn.:—*a*, larva; *b*, pupa; *c*, male beetle; *d*, *e*, *f*, *g*, mandible, antenna, leg and maxillary palpus of larva—after Riley.

In addition to the characters given in the table of families, the Cetoniidæ are distinguished by being somewhat flattened, or nearly level on the back, whilst the Lamellicorns generally are regularly convex; the elytra are a little narrower at the tip than at the base, and in the Cetoniides proper the side pieces of the mesothorax are continued upwards, so as to form a little piece which is easily seen at the shoulders, between the thorax and the elytra. The scutellum is longer than it is broad, and almost always triangular and pointed, whilst in both the Melolonthides and Rutelides it is as broad as it is long, and rounded behind. The Cetoniides proper are one of the most splendid groups of Coleopterous insects, and some of the tropical species vie in magnitude with the Dynastides. Indeed the *Goliathus giganteus*, of Lamark, from the west coast of Africa, is probably the largest Coleopterous insect known, being upwards of four inches in length, and two inches in breadth. The Cetoniæ do not raise their elytra in flying like other beetles, but spread their wings out laterally from beneath them, the elytra being a little hollowed behind the shoulders, to facilitate the operation. These are pre-eminently flower-beetles, and the mouth organs are furnished with a brush of hairs with which they collect the pollen. Many of the Cetoniæ differ in their habits from the majority of herbivorous Lamellicorns, by being actively diurnal, being often seen feeding upon pollen, and flying from flower to flower, in the heat of the day. We have in N. America eighteen species of Cetoniides proper, and twenty species belonging to the aberrant genera.

Our species of Cetoniides form six genera, which are very unlike in color and general appearance.

A. Side pieces of the mesothorax visible above; thorax somewhat triangular or trapezoidal, and nearly as wide at base as the elytra. *Cetoniides* proper.
  B. Thorax with a lobe behind representing and covering the scutellum................GYMNETIS, 2
  B B. Scutellum distinct..EURYOMIA, 14
A A. Side pieces scarcely or not visible above; thorax roundish or square, and decidedly narrower than the elytra.
  C. Body almost naked; color black.
    D. Thorax square, with prominent angles. Clypeus turned up in front. Size medium: CREMASTOCHILUS, 13
    D D. Thorax roundish, with obtuse angles. Clypeus plane. Size very large: OSMODERMA, 3
  C C. Body densely clothed with hairs or scales; colors various.
    E. Hind coxæ contiguous. Body hairy; colors variegated......................TRICHIUS, 5
    E E. Hind coxæ wide apart. Body covered with minute scales; ground color dark brown: VALGUS, 3

The *Gymnetis nitida*, Linn., (Fig. 41) is a beautiful velvetty-green beetle, three-quarters of an inch long, the bodies margined all around with orange-yellow, found throughout the Eastern States. Its larva has been found by Mr. Riley feeding on strawberry roots, and when out of the ground crawls with ease on its back. The *Euryomia fulgida*, Fab., is a glossy green species, two-thirds of an inch long; the elytra tinted with

pale bronze, and with an irregular number of minute white points, and four large white spots on the tip of the abdomen. It is found on flowering shrubs, and is not uncommon at the west. The *Eur. Inda*, Linn., is our most common species of Cetonia. It varies in length from half to two-thirds of an inch; it is of a yellowish-brown color, the elytra sprinkled all over with small irregular black spots. It is sometimes troublesome by burrowing into ripe fruit, and also by feeding upon sweet corn in the milk. The larvæ, probably, like those of other known species, live in rotten wood, as the perfect insects are often seen flying over chip-yards, probably in search of a convenient nidus for their eggs. The *E. melancholica* is a much smaller species, almost black, with irregular transverse white lines on the elytra.

Cremastochilus, Knoch, contains a considerable number of rather rare species, half an inch or a little less in length, of a deep black color, sometimes with a few small white marks on the elytra. The mouth is peculiarly constructed. The clypeus or anterior margin of the head is thickened, and turned up, and the mentum is much enlarged, projecting forward so as to almost close the oral cavity, and its sides hang down like two curtains, which suggested the generic name, which means *hanging lip*. They have been found under stones beneath which were ants' nests; but their natural history is imperfectly known.

Osmoderma contains three American and one European species. The *O. eremicola*, Knoch, is upwards of an inch in length, black, with a faint chestnut tint, and with a smooth shining surface. The *O. scabra*, P. de B., is an inch long, black, the elytra being rough, with irregular, coarsely punctured striæ. *Trichius*, Fab., is composed of a number of closely allied species or varieties, the type of which is the *T. lunulatus*, Fab., a very common and pretty insect, often seen upon flowers in our gardens, basking in the hot sunshine, but readily taking to flight. It is a little less than four-tenths of an inch in length; the thorax dark brassy-green, the elytra more or less reddish on the disc, widely bordered with black, and with two transverse white marks on the side of each elytron. The under side is densely hairy.

Valgus contains three small brown species, densely covered with minute whitish scales. They are easily distinguished by their distant posterior coxæ, and their much shortened elytra.

Sixth Sub-section, SERRICORNES.

Antennæ serrate or saw-toothed. Food-habits various.

This sub-section of beetles with five-jointed feet is primarily distinguished, as its name implies, by the serrate or saw-toothed character of the antennæ. The serrate antenna is similar to the filiform in being slender, and usually of the same width throughout; but differs from it in

having each joint project more or less inwards, that is, towards the antennæ of the opposite side, so as to give it a saw-toothed appearance; and this projection sometimes extends so far as to form what is called the pectinate or comb-toothed antenna; and when these processes are nearly as long as the antenna itself, they form what is called the *flabellate*, or branched antenna. But in many of the insects which are naturally classed in this sub-section this character of the antennæ is either wholly wanting, or so slightly developed that it can be scarcely distinguished from the filiform, and therefore it cannot be relied upon by the student without the aid of other characters. The only other insects of the pentamerous section, however, with which they could be confounded are the Filicornes proper of the first subsection, comprising the predaceous Ground-beetles, Cicindelidæ and Carabidæ, and the predaceous Water-beetles or Dytiscidæ. From the latter they are distinguished, not only by the want of any general resemblance, but more definitely by their legs not being fitted for swimming. And the ground beetles are distinguished by having apparently six palpi, and more conspicuously by their large egg-shaped posterior trochanters.

The Serricornes, as a whole, do not constitute a natural division, being composed of two very dissimilar tribes, viz: the saw-horned wood-beetles, comprising the families Buprestidæ and Elateridæ, and the soft-winged carnivorous beetles, Lampyridæ, Telephoridæ, etc.; and in addition to these a number of small groups (Ptinidæ, Lymexylonidæ, Rhipiceridæ and Cupesidæ,) which do not strictly belong to either of the leading tribes, but which are usually classed with one or the other to avoid the creation of a great number of primary groups.* In accordance with our plan of classifying insects, as nearly as possible, according to their habits and the nature of their food, and at the same time leaving the two large and natural tribes just referred to undisturbed by discordant elements, we have adopted the expedient of throwing together a number of these small and heterogeneous families, under the title of *Aberrant Wood-beetles.* Thus arranged the Serricorn Coleoptera will form three tribes, which may be designated as follows:

1st Tribe. *Saw-horned wood-beetles.* STERNOXI, Latreille. Head inserted in the thorax as far as the eyes. Antennæ serrate or filiform. Pro-sternum advanced in front, and also prolonged behind into a point which is received into a cavity of the meso-sternum. Body elongate, or elliptical, moderately convex, and of a very hard consistency. Legs short and retractile. Anterior and middle coxæ small and globulus. Families: Buprestidæ, Elateridæ and Cebrionidæ.

* "The creation of new families is a measure which should not be resorted to except at the last extremity."—LACORDAIRE, Genera des Col., IV, 258.

2d Tribe. *Aberrant wood-beetles.* XYLOTROGI partly, Latreille. Body short, with the head bent under the thorax, or elongate, with the head free. Antennæ various. Families: Ptinidæ, Lymexylonidæ, Rhipiceridæ and Cupesidæ.

3d Tribe. *Soft-winged predaceous beetles.* MALACODERMI, Latreille. Head free, but often partly or wholly covered by the thin anterior margin of the thorax. Antennæ serrate or filiform. Body more or less elongated, and depressed, soft, and with flexible elytra. Anterior coxæ conical and prominent, with large trochantins.* Families: Lampyridæ, Telephoridæ, Melyridæ, Cleridæ, Dascyllidæ.

TRIBE IX.

SAW-HORNED WOOD-BEETLES.

Lignivora serricornia. STERNOXI, Latreille.

The term *Sternoxi*, meaning *sharp-breasted*, given to these insects by Latreille, refers to their most distinctive character, namely, the extension of the pro-sternum or front breast-plate, backwards in the form of a sharp point, which is received into a corresponding notch or cavity in the meso-sternum. The sternum is also much advanced in front, and the fore legs are set remarkably far back from its anterior edge. The anterior coxæ or hip-pieces are almost globular, but not prominent. The antennæ are rather short, sometimes distinctly serrate, and sometimes simply filiform. The legs are short and capable of being contracted closely upon the body. They are of an oblong form, and usually of a very hard consistency. The larvæ will be described under their respective families. They are vegetable feeders, and are generally found in wood in a state of partial decay. The two first families are numerous in species, but the Cebrionidæ are few and rare, and no species has been found in the Northern States.

They comprise the three following families:

A. Body very firm; prosternal point elongated; abdomen with five segments.
- B. Prosternal point immovable; antennæ finely serrate; anterior and middle legs with trochantins; colors metallic .... BUPRESTIDÆ.
- B B. Prosternal point movable; antennæ often filiform; legs without trochantins; colors generally brown or black, and with the surface usually finely pubescent.. ELATERIDÆ.

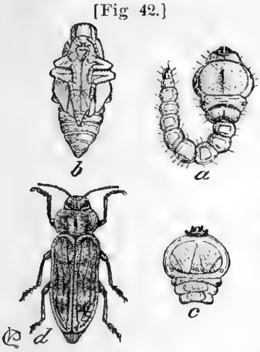
A A. Body moderately firm; prosternal point short; abdomen with six segments: CEBRIONIDÆ.

* The trochantin is an additional or supernumerary joint between the coxæ and the thigh, giving the latter the appearance of being composed of two pieces.

Family XXXIV. BUPRESTIDÆ.

The name Buprestis was given by the ancients to some kind of noxious insects which cannot now be determined; but it was subsequently given by Linnæus to the insects of the present family. They might properly be called, in English, *metallic beetles*, in reference to their very hard and inflexible bodies, and their metallic coloring. They are further distinguished by their short, slender and finely but distinctly serrate antennæ, and the presence of trochantins in the anterior and middle legs. They are usually of an oblong elliptical form, and somewhat depressed or flattened, but some of the smaller species are either elongate, slender, and almost cylindrical, or short and ovate. The scutellum is very small and sometimes wanting. The Buprestidæ are pre-eminently a tropical family, and in those torrid regions they attain a large size, and reflect the light from their polished bodies with an almost dazzling brilliancy.

[Fig 42.]



CHRYSOBOTHRIS FEMORATA, Fab:—Flat-headed borer of the apple tree, and of the soft maple; *a*, larva; *c*, head of larva, underside; *b*, pupa; *d*, beetle—after Riley.

The larvæ present two very distinct forms. The usual form is at once distinguished from all other Coleopterous larvæ by the enormous development of the first segment of the body, into which the head is partly retractile. The other segments are narrow and slightly flattened. This form of the larvæ has caused them to be compared with tadpoles, and the French authors describe them as resembling a pestle. They are wholly destitute of legs.

These larvæ usually reside under the bark of trees in a state of incipient decay, but some of them penetrate into the solid wood. Some of the smaller species inhabit the stems of small trees or shrubs, causing them to enlarge so as to resemble galls. An example of the former is the flat-headed borer of the apple and soft maple trees; and an example of the latter is the raspberry cane borer, or larvæ of the *Agrilus ruficollis*.

The other form of Buprestide larva is that of the Brachyides or short-bodied Buprestidæ. In these the first segment is not enlarged, the body is slender and tapering, and each of the three first segments is furnished with a pair of very small feet, placed wide apart. These species are all very small, and such of them as are known are leaf-miners. In an economical point of view, the Buprestidæ occupy a peculiar position, intermediate between the genuine wood-borers (Cerambycidæ and Scolytidæ), which bore into the solid wood of trees, and those kind of wood-beetles which (like the Elateridæ and many of the Heteromer-

ous beetles) inhabit wood and bark in an advanced state of decay. In accordance with this position, they are usually the first insects to attack trees which have been injured by sun-scald, or which have otherwise had their vitality weakened.

The following are the genera of Buprestidæ:

A. Hind coxal plates* much widened at their inner extremities. Body oblong and somewhat depressed, and more or less elliptical or narrowed at the two extremities. Size usually large or medium. (*Buprestides* proper.)

B. The epimera (or hinder side pieces) of the metasternum triangular and exposed; prosternum acutely angulated behind.

C. Mesosternum and metasternum united without suture. First joint of the hind tarsi as long as the second and third united. Size large or very large .... CHALCOPHORA, 7 sp.

C C. Mesosternal suture distinct; size rather large or medium.

D. Elytra tapering to a point and slightly separated at their tips; 1st joint of hind tarsi scarcely longer than 2d .... DICERCA, 24 sp.

D D. Elytra moderately narrowed behind. 1st tarsal joint elongated .... BUPRESTIS, 23 sp.

B B. Epimera of the metasternum partly covered by an anterior prolongation of the margin of the abdomen. Prosternum acutely angulated behind.

E. Front with a pit or depression for the insertion of the antennæ. Size moderate: CHRYSOBOTHRIS, 43 sp.

E. Front without pit. Size small.

F. Thorax waving at its junction with the elytra .... MELANOPHILA, 10 sp.

F F. Thorax cut straight across behind .... ANTHAXIA, 14.

A A. Hind coxal plates but little widened at their inner extremities. Size never above medium; usually small or very small.

G. Front without pits for the insertion of the antennæ. Thorax straight behind: Scutellum none. Body clothed with short erect hairs. Colors often variegated: ACMÆODERA, 23 sp.

G G. Front pitted for antennæ. Thorax angulated behind. Scutellum distinct. Body not hairy.

H. Body elongated, narrow, almost cylindrical. Prosternum without grooves for the reception of the antennæ .... AGRILUS, 40 sp.

H H. Body short and broad. Prosternum with grooves for the antennæ. Tarsi very short.

I. Body ovate; scutellum small; tibiæ slender .... BRACHYS, 8 sp.

I I. Body sub-triangular; scutel large; tibiæ dilated .... METONIUS, 2 sp.

The largest N. A. species of Buprestis is the *Chalcophora virginiensis* of Drury, nearly or quite an inch in length, of a dark coppery or blackish color, and a very uneven surface, caused by elevated lines and depressed square-shaped spots. The larva inhabits the trunks of different kinds of pine trees, and the perfect insects are to be found, therefore, only in pine growing regions. The *Dicerca divaricata*, Say, is three-quarters of an inch or more in length, copper colored, with a granulated surface. It is distinguished at once by its tapering elytra, separated at the tips. Its larva bores into the trunks of cherry and peach trees. We have another, smaller and more obscure species, the *D. lurida*, Fab., the larva of which inhabits the hickory. The *Chrysobothris femorata*, (Fig. 42) an obscure bronze-black species, rather less than half an inch in length, is the parent of the well known *flat-headed borer*, so injurious to apple trees, and also to the soft maple.

* The hind coxal plates are the flat and narrow transverse pieces which border the under side of the thorax behind, and are separated by a suture from the metasternum. They are marked C X P in Fig. 3.

The genus *Acmœodera*, Esch., contains a number of small species of a bronzed-brown color, sometimes with purple and green reflections, and the elytra prettily spotted with yellow. The colors are somewhat obscured by the surface being clothed with stiff erect hairs. The *A. tubulus*, Fab., and the *A. pulchella*, Herbst, are the most common species. They are often found in abundance on the flowers of the Coreopsis.

The genus *Agrilus*, Solier, is easily recognized by the elongate, slender, and cylindrical form of the species. The raspberry borer, *Agrilus ruficolis*, Fab., may be taken as the American type of this genus. It is three-tenths of an inch long, black, with a coppery-red thorax.

Buprestis, including *Anchylochira*, Esch., is composed of species mostly between a half and three-quarters of an inch in length, of a brassy-green or a brassy-black color, and often ornamented with yellow spots on the elytra; some also have yellow spots on the sides of the venter.

The species of *Melanophila*, Esch., are from three to five-tenths of an inch in length, black, sometimes with obscure bronze or purple tints. Some species have four yellow dots on each elytron.

The species of *Anthaxia*, Esch., are less than three-tenths of an inch long, brassy-black, and without spots. The head and thorax are sculptured with shallow punctures, with the intervening lines forming a fine net-work.

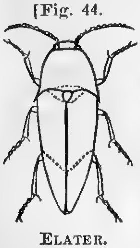
We have two common species of *Brachys*, Sol., the *ovata*, Weber, and the *ærosa*, Melsh., *(terminans ? Fab.)*; and several rarer species, some of which may be only varieties or races of the first. The *B. ovata* is two-tenths of an inch or more in length, of a bronze color, variegated with spots and imperfect transverse waving bands of whitish and copper colored pubesence. The *B. terminans* is smaller and less distinctly variegated, but most readily distinguished by the pale tips of the elytra.

Metonius, Say, (*Pachyscelus*, Solier,) has two species, about an eighth of an inch in length; the *lævigatus*, Say, wholly black; and the *purpurea*, Say, black, with dark-blue elytra.

Family XXXV. ELATERIDÆ.

The term *elater* applied to these insects by Linnæus, and the name *ship-jacks*, sometimes given to them by English authors, have reference to their most striking peculiarity, that of having the faculty, when placed on their backs, of righting themselves by a spasmodic jerk, by which they are thrown several inches from the surface upon which they are placed. In this operation the sharp point which projects backwards from the pro-sternum is thrown violently into the corresponding socket in the meso-sternum.

[Fig. 44.



ELATER.

They are distinguished from the allied Buprestidæ, not only by this saltatory power, but also by the posterior angles of the thorax being prolonged backwards to a point, so as to embrace the base of the elytra, and by the bases of the thorax and of the elytra sloping downwards towards each other, which, in addition to a slight separation between them, permits the freedom of motion which these parts have upon each other. The thighs moreover are almost or entirely destitute of the accessory joint at their base called the trochantin. The elaters are also readily distinguished by their usually dull brown colors, very rarely changing to black or red, and by their surface being almost always clothed with a fine pubescence.

[Fig. 44.]

LARVA OF ELATER.

The larvæ are elongate, slender, of the same width throughout and of a hard and almost horny consistency, and furnished with short legs. The last segment is sometimes forked at the extremity, sometimes 3-toothed, and sometimes entire. They bear a strong resemblance to the meal-worms or larvæ of Tenebrio, but differ in the structure of their mouths.

These larvæ go by the common name of wire-worms. With respect to their food they may be divided into two classes: those which live in rotten wood, being frequently found under the bark of decayed stumps and prostrate logs, and sometimes, but rarely, penetrating into solid wood*; and those which feed upon the roots of grasses and of other plants. The natural food of the larvæ of the latter division appears to be the roots of grasses, both wild and cultivated, but from these they spread to the roots of almost all kinds of cultivated plants, including Indian corn and the small grains, and various kinds of garden vegetables. In some localities they rank amongst injurious insects of a very serious character.

The Elateridæ constitute one of the most extensive, and one of the most natural families of Coleoptera, but their division into minor groups is very difficult, on account of the great numbers and the strong general resemblance of the species. In treating upon this subject, Lacordaire makes the following remark: "The classification of this family presents extreme, and perhaps insurmountable difficulties. If we examine the works of the most recent authors, Germar and Erichson, we shall see that both of them despair of the classification of these insects. The latter, indeed, has expressed the wish that some new characters may yet

* Mr. C. V. Riley has shown me a specimen of *Hemirhipis facicularis*, Fab., distinguished for its beautifully pectinated antennæ, which was reared by him from a larva which he found boring through the heart wood of the Pecan Hickory, thus proving that some of the Elateridæ are genuine wood-borers and corroborating the propriety of placing them in the same tribe with the wood-boring Buprestidæ. [Since the above was written, Mr. Riley informs me that he strongly suspects that the Hemirhipis larva was preying on that of Clytus pictus which was boring the same tree, and not feeding on the wood itself.]

be found which will enable us to establish it upon rational bases; but many months' assiduous labor compels me to declare that such characters do not exist, and that we shall search for them in vain. We must trust therefore to tradition to supply the inadequacy of science."

They comprise two well marked but very unequal sub-families, as follows:

First Sub-family, *Eucnemides.* Antennæ inserted upon the front. Head bent down upon the breast in repose.

Second Sub-family, *Elaterides.* Antennæ inserted under the margin of the front. Head directed forwards.

Sub-family EUCNEMIDES.

This sub-family is composed of a moderate number of small, comparatively rare, black or brown insects, and more or less clothed with minute yellow hairs. They resemble the Elaterides in their elongated slender forms, but are distinguished by their vertical heads, the mouth being inferior, and not anterior as in the Elaters. The antennæ also, as a general rule, are more strongly serrate, and in the males often pectinate or even flabellate. The palpi are often terminated by a widened or hatchet-shaped joint. Whilst the perfect insects strongly resemble the Elaterides, such of their larvæ as are known have a striking resemblance to those of the preceding family of Buprestidæ, both in form and habits, being abruptly enlarged at their anterior extremity, and being found in wood in an incipient state of decay.

The following tables exhibit those genera which are most common or most numerous in species:

A. Antennæ inserted in pits on the front, at some distance apart; claws not serrate.
  B. Maxillary palpi with the last joint acute........MELASIS, 4 sp.
  B B. Maxillary palpi with the last joint dilated.
    C. Grooves for the antennæ under the margin of the thorax.
      D. Antennæ serrate........EUCNEMIS, 3.
      D D. Antennæ filiform........FORNAX, 14.
    C C. Antennal grooves wanting........NEMATODES, 3.
A A. Antennæ inserted close together on the front; claws serrate........CEROPHYTUM, 2.

Sub-family ELATERIDES.

A. Sternum with deep grooves for the reception of the antennæ........ADELOCERA, 16 sp.
AA. Sternal grooves obsolete or wanting.
  B. Mesosternum connate with the metasternum; very large species clothed with whitish scales, and with two eye-like spots on the thorax........ALAUS, 4.
  B B. Mesosternal suture distinct, and without the other above mentioned characters.
    C. Hind coxal plates suddenly dilated inwards, and prolonged into a tooth at the posterior angle; claws never pectinate.
      D. Prosternal spine truncate; scutellum heart shaped........CARDIOPHORUS, 32.
      D D. Pro-sternal spine acute; scutellum oval.
        E. Anterior margin of the front not elevated; coxal plates moderately dilated; large species with distinctly serrate antennæ........LUDIUS, 5.

E E. Anterior margin of the front slightly elevated, forming a transverse ridge which separates the front from the upper lip. Size sometimes large, but usually medium or small.

F. Prosternal sutures single and convex on the outer side; tarsi slender; size small: CRYPTOHYPNUS, 31.

F F. Prosternal sutures double and straight, or concave on the outward side.

G. Tarsi simple .... ELATER, 51.

G G. Fourth tarsal joint bilobed .... MONOCREPIDIUS, 15.

G G G. Second and third joints lobed .... DICREPIDIUS, 8.

C C. Hind coxal plates gradually and but slightly dilated inwardly and often without a sharp posterior angle; claws sometimes pectinate.

H. Front convex; mouth inferior .... AGRIOTES, 12.

H H. Front flattened, and with an elevated margin; mouth anterior.

I. Claws pectinate .... MELANOTUS, 47.

I I. Claws simple.

K. Eyes prominent; 1st joint of hind tarsi as long as the 2d and 3d united: ATHOUS, 25.

K K. Eyes small; 1st joint of hind tarsi less elongated .... LIMONIUS, 39.

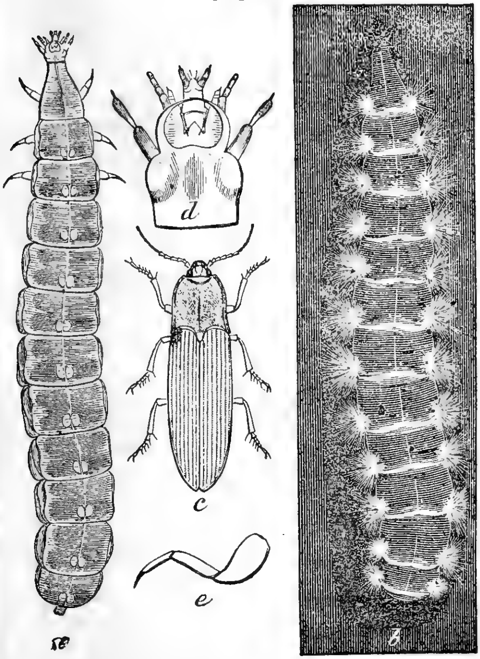
H H H. Front flattened, without elevated margin; mouth anterior.

L. Size large; color shining black .... MELANACTES, 8.

L L. Size moderate; colors various .... CORYMBETES, 93.

The Elaterides proper constitute an extensive series of comparatively homogeneous insects, the great majority of which are of a uniformly brown color, and varying in length between one-quarter and three-quarters of an inch; though there are a few large or very large species. The determination of the genera and species of this family requires, therefore, an amount of study and an aptness for observations of this kind, which can scarcely be expected from any but professed entomologists. We will only refer to a few species which are remarkable for their size, or for their exceptionally varied coloring.

[Fig. 45.]



MELANACTES PICEUS, DeG.—*a*, supposed larva, as seen by day; *b*, same as seen by night; *c*, beetle; *d*, enlarged head and parts; *e*, enlarged leg of same—after Riley.

Our largest and most striking species is the well known *Elater (Alaus) occulatus*, of Linnæus. It is usually nearly an inch and a-half in length, though individuals are not unfrequently seen which scarcely exceed an inch. Its gray color is produced by a dense sprinkling of small whitish spots and lines upon a black ground. These spots are composed of minute whitish scale-like hairs. But its most conspic-

uous character is the two large eye-like spots on the top of the thorax, which are expressed by the specific name. The larva inhabits partially decayed wood, and is often found in the trunks of old apple trees. The *Elater rubricollis*, Say, is a little more than half an inch long, black, with a light-red thorax, bordered and pointed behind with black. The *Elater sanguinipennis*, Say, is black, with light-red elytra; three-tenths of an inch in length. The *E. apicatus*, Say, is similar, but larger, being nearly half an inch in length, and the elytra are tipt with black. The *E. nigricollis*, Say, varies from less than half to three-quarters of an inch in length; black, with whitish elytra. The *E. linteus*, Say, resembles the last, but is distinguished by having the suture and tip of the elytra black. *E. scapularis*, Say, is a little less than four-tenths of an inch long, greenish-black, with the base of the elytra and the hind points of the thorax, clay-yellow. The tarsal joints are lobed beneath. It is now included in the genus *Athous*. The *Limonius armus*, Say, is also light-red on the shoulders of the elytra, but the thorax is wholly black, the tarsi are simple, and the length is only a quarter of an inch. Several species of *Corymbetes* have the elytra brownish-yellow with transverse zig-zag black bands. *C. hieroglyphicus*, Say, half an inch long, has two bands; and *C. hamatus*, rather smaller, has but one band near the tip.

The *Melanotus fissilis*, Say, (*cinereus*, Weber?) and the *M. communis*, Sch., plain brown species, usually about half an inch in length, but subject to considerable variation in size, are amongst our most common beetles. The two species closely resemble each other, but the latter is a little smaller, and the thorax is proportionally longer and less convex. They are distinguished from other and somewhat similar Elaters by their pectinate claws. They are sometimes found under the bark of dead trees, having probably recently emerged from the pupa state. But they are also found upon the leaves of trees, to which their pectinate claws enable them to adhere. We have repeatedly seen them at rest in the enclosure formed by the tying together of the leaves of the black walnut, by the larvæ of the little moth, *Phycita juglandis*, LeB.; but for what purpose was not apparent.

The *Melanactes piceus*, DeG., (Fig. 45) is a large glossy black species, an inch or more in length. It is not uncommon in the latitude of southern Illinois, where it is sometimes jarred from peach trees upon the curculio-catcher. Mr. Riley has found and figured its supposed larva, which is one of the most beautiful objects, and often attracts the attention of the curious in the southern part of the State, by its luminosity; the animal glowing in the dark with a beautiful green light as represented in the figure.

TRIBE X.

ABERRANT WOOD-BEETLES.

Lignivora aberrantia.

Under the title of aberrant or exceptional Wood-beetles, as stated in the general remarks upon the Serricornes, we have included, for the sake of brevity and convenience, a number of small families, some of which have but a remote relationship to the others, but which cannot naturally be united with any of the larger tribes.

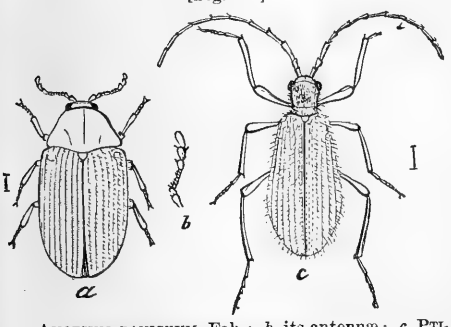
This tribe contains two very dissimilar groups. In the first, which is composed of the family of Ptinidæ, including the sub-family of Bostrichides, the body is rather short and thick, or moderately elongated and cylindrical, and the head is bent down and mostly or wholly concealed under the vaulted or hood-like thorax.

In the other group, which includes the small families of Lymexylonidæ, Cupesidæ and Lyctidæ, the body is much elongated and often depressed, and the head is free and exposed, and sometimes attached to the thorax by a short neck. These three families combined do not contain more than a dozen known American species, most of which are rare, and are found mostly under the bark of decaying trees. Many authors include them in some one or other of the larger families.

Family XXXVI. PTINIDÆ.

This is a family of moderate extent, composed of small insects, rarely exceeding a quarter of an inch in length, and often only about half that length, and usually of a cinnamon-brown color, sometimes black and sometimes ornamented with patches of whitish scales. Their most distinctive character is the vaulted or hood-like form of the anterior part of the thorax, the head being bent under it or partly retracted within it, so that it can be scarcely or not at all seen when the insect is viewed from above. The antennæ are generally filiform, but in *Bostrichus* they terminate in three larger joints. The tarsi are simple. The larvæ resemble those of the Lamellicorn beetles, in miniature, being soft and white, and usually lying in a curved or semi-circular position. They have six legs, but do not use them in crawling in the usual way, but draw themselves along upon their sides.

[Fig. 46.]



a, ANOBIUM PANICEUM, Fab.: *b*, its antennæ; *c*, PTINUS BRUNNEUS, Dufs.—after Riley.

The *Ptini* proper subsist upon substances in a state of incipient decay, and are often found in cellars and out-buildings. The *Anobii* are usually found in wood more or less decayed; but the *Bostrichi* bore into solid wood, and are often seriously injurious, more especially to forest trees. Indeed, the last mentioned insects bear so striking a resemblance, both in their short cylindrical forms and their eminently wood-boring habits, to the short-horned wood-borers *(Scolytidæ)*, in the tetramerous section, that one feels strongly tempted to place them in the latter tribe; but in the details of their organization they are more closely allied to the more highly organized Ptinidæ, especially in the more fully developed antennal club, labrum, and maxillary palpi. The larvæ also have six feet, whilst those of the Scolytidæ are footless.

The following are the principal genera:

A. Antennæ filiform, sometimes branched. Tibial spurs very small or wanting; tarsi distinctly 5-jointed.

B. Head and thorax much narrower than the elytra; antennæ filiform and simple and inserted upon the front, and about as long as the body.......................................PTINUS, 8 sp.

BB. Form cylindrical or sub-globular. Antennæ usually either branched or with the three last joints longer than the others, and inserted before the eyes.

C. Antennæ simple, but with the three terminal joints elongated.......................ANOBIUM, 22.

C C. Antennæ branched in the male, serrate in the female...............................PTILINUS, 3.

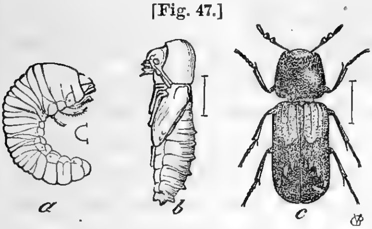
A A. Antennæ terminating in three larger and somewhat serrate joints; tibial spurs distinct; tarsi apparently 4-jointed. Thorax asperous. Elytra often truncated and toothed behind: BOSTRICHUS, 19.

The *Ptinus fur*, Linn., is three-twentieths of an inch long, light brown, with two whitish bands across the elytra, interrupted in the middle. The thorax is uneven, having a tubercle on each side and two on the back. This insect feeds upon almost all kinds of dried animal matter, and is often very injurious in museums of natural history. It was originally a native of Europe, but has become disseminated over the civilized world. We have a very similar species in this country, the *humeralis*, of Say, which is regarded by some as only a variety of the European species. We have also another common species, often found in company with the others, in cellars and out-buildings. This is the *Ptinus brunneus*, and is distinguished at once from the others by being wholly of a light-brown color, and destitute of the bands on the elytra.

Our most common species of Anobium is the *A. tenuestriatum*, Say, scarcely three-twentieths of an inch in length, of a uniform, cinnamon-brown color, with a microscopically fine silken pubescence, and the elytra with fine impressed lines or striæ. This species is also injurious to cabinets and herbaria. It may often be caught upon the wing in or about our houses.

The genus Bostrichus contains a number of small species, which, in their larva state, are genuine wood-borers, and some of which are seriously injurious both to fruit and forest trees. The *B. bicaudatus*, a

[Fig. 47.]



BOSTRICHUS (SINOXYLON) BASILLARE, Say.: *a*, larva; *b*, pupa; *c*, beetle—after Riley.

plain, grayish-brown species, three-tenths of an inch, or a little more, in length, with one tooth at the end of each wing-cover, is very common at the West, where it sometimes excites serious apprehensions in the spring, by boring into the twigs of apple trees; but their injury is of a transient character. The *B. basilaris* (Fig. 47) is two-tenths of an inch in length, black, with reddish antennæ, and each elytron with a large red spot on the base, and three teeth at the end. The larva of this species is usually found in the shag-bark hickory, which it sometimes destroys, by riddling the solid trunk with innumerable holes. It also sometimes infests fruit trees, and has been found in the grape vine.

Family XXXVII. LYMEXYLONIDÆ.

A small family of anomalous insects, founded upon the genus *Lymexylon*, Fab., a term derived from the Greek *lume*—a *destroyer*, and *xulon*—*wood.* They are elongated narrow beetles, with free heads, and short serrate antennæ; the elytra sometimes remarkably shortened, and with the maxillary palpi often furnished with long branching appendages. We have but few N. A. species, all of which are rare. The *Lymexylon nivale* is notorious for the extensive destruction sometimes produced by its larvæ to the ship timber floating in the docks in the northern part of Europe. At the suggestion of Linnæus the timber was sunk under water at the time of the year when the females deposit their eggs, and was thus preserved from their attacks.

Family XXXVIII. CUPESIDÆ.

This is another small anomalous family, containing but four known species, two of which inhabit N. America, one is found in Chili, and the other in the Phillipine Islands. The form is elongate, the elytra are strong, sculptured with longitudinal ribs and square depressions between them. The antennæ are filiform, and the head is tuberculate behind, and attached to the thorax by a distinct neck. The *Cupes cinerea*, of Say, is widely distributed but of rare occurrence. Mr. Say, however, speaks of it as being sometimes found in considerable numbers about old frame buildings.

Tribe XI.

SOFT-WINGED PREDACEOUS BEETLES.

Carnivora mollipennata. Malacodermi, Latreille.

The insects of this tribe are distinguished from most other Coleoptera, and from all others in the pentamerous section, by their soft bodies and their thin and flexible elytra. The antennæ are usually more or less serrate; the palpi terminate in a widened triangular or hatchet-shaped joint; the thorax is usually surrounded with a thin projecting margin; and the fourth-joint of the tarsi is more or less bi-lobed. The term *Malacodermi*, meaning soft-skinned, given to these insects by Latreille, expresses their most remarkable character, and is in general scientific use.

They are exclusively carnivorous in their diet, both in the perfect and the larva state, feeding upon small worms, larvæ and snails, and are therefore one of the agencies for checking the excessive multiplication of other insects.

The larvæ are elongated, flattened, usually a little tapering toward each end, of a tough or leathery texture, and of a brown or black color, and often clothed with short hairs. They are furnished with slender, sharp and projecting mandibles, with which they sieze their prey. They are sometimes found on trees, but usually on the ground or under the bark of dead trees, in search for small wood-eating larvæ. A few are found in ants' nests.

This tribe comprises the three following families:

A. Body and wing-cases flexible; thorax almost level, with a thin margin all around. Antennæ not enlarged at the tip.
   B. Antennæ inserted upon the front or upon the base of the rostrum; front without membraneous suture; 4th joint of tarsi more or less bi-lobed; palpi clavate..Lampyridæ.
   B B. Antennæ inserted laterally before the eyes; epistoma separated from the front by a membraneous suture; tarsi entire; palpi usually filiform. Melyridæ.
A A. Body rather firm; thorax convex, without a sharp margin or with a very narrow one, low down upon the side; antennæ generally widened at the tip; palpi clavate.. ....Cleridæ.

Family XXXIX. LAMPYRIDÆ.

This family contains the well-known fire-flies, or lightning-beetles, and the family name, from a Greek word meaning *to shine*, was intended to express this quality. This property is possessed both by the larvæ and the perfect insects, but only a small number of species are endowed with it. Their principal characters have been given in the foregoing table and in the general description of the tribe. They are usually medium sized,

sometimes small, but rarely very small. They are mostly plain insects without brilliant colors; usually black or brown, and many have the thorax margined with red or yellow.

The Lampyridæ comprise three sub-families, which may be characterized as follows:

A. Elytra reticulated; middle coxæ separate; head partially covered by the anterior margin of the thorax..LYCIDES.

A A. Elytra not reticulated; middle coxæ contiguous.

B. Head nearly or quite covered by the thorax; antennæ usually approximate; side pieces of metasternum rather wide ....LAMPYRIDES.

B B. Head wholly uncovered by the thorax; antennæ rather distant; side pieces of metasternum tapering to a point behind ..............TELEPHORIDES.

Sub-family LYCIDES.

The Lycides are distinguished by their reticulated elytra, produced by elevated lines and cross-lines. The genus Lycus, and some others, have the head more or less prolonged in front in the form of a snout.

A. Head with a distinct beak; antennæ inserted in front of the eyes; elytra usually widened behind: LYCUS, 3 sp.

A A. Head without distinct beak; antennæ inserted between the eyes.

B. Elytra widened behind; thorax carinate ....CALOPTERON, 7.

B B. Elytra parallel; thorax not carinate ....EROS, 16.

Lycus, Fab., including *Dictyopterus*, Latr., which differs only in having the rostrum shorter and more robust, contains three known North American species.

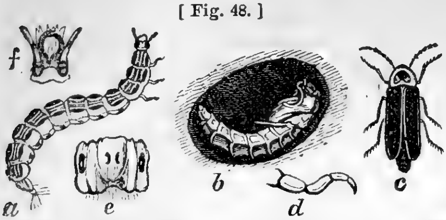
Calopteron, Guerin, contains a number of species, two of which at least are rather common and conspicuous insects: the *C. reticulatum*, Fab., five or six-tenths of an inch in length, yellow, with the middle of the thorax, a broad band across the elytra, and a broad tip of the same, black; and the *C. terminale*, Say, of the same size and color, but without the middle band on the elytra. A much smaller species, the *C. dimidiatum*, Fab., (*scapulare*, Newman,) is blackish, with the margin of the thorax, and the tips of the shoulders, yellow. The antennæ are strongly pectinate, or branched. It is the type of the genus *Cænia*, of Newman.

Eros, Newman, contains many species, the most conspicuous of which is the *E. coccinatus*, Say, four-tenths of an inch long, and of a bright scarlet color.

Sub-family LAMPYRIDES.

The remarks made above upon the present tribe of soft-winged Carnivora, and upon the family of Lampyridæ, apply especially to the subfamily of Lampyrides proper, and need not be here repeated. Their

[Fig. 48.]



PHOTINUS PYRALIS, Linn.:—Common fire-fly; or, more properly, Lightning-beetle; *a*, larva; *f*, *e*, *d*, head, under side of segment, and leg of same; *b*, pupa in its earthen cell; *c*, beetle—after Riley.

most distinctive character is the extension of the thin thoracic margin, which is narrow in the other sub-families, but is here expanded so as, in most cases, to completely cover the head. It is in this sub-family that we find the species remarkable for their luminous or phosphorescent property, which is possessed by no other insects except a few of the Elateridæ.* This property is located in one or more of the segments on the under side of the abdomen. The luminous power is intermittent, being exhibited by flashes, and is evidently controlled by the will of the insect. It is a vital phenomenon, and consequently ceases after death; but the luminous segments can be distinguished in the dried specimen by their uniformly yellow color.

The historic and poetic *glow-worm* is the wingless female of the European *Lampyris noctiluca*, Linn. But in most of our species both sexes are furnished with wings.

The Lampyrides are nocturnal insects, being sluggish by day, and found sometimes on the ground, and sometimes resting upon the foliage of trees, or upon the palings of fences. But at night they launch out upon the wing, sometimes in immense numbers, especially in low meadows, which they illuminate with their multitudinous flashes of phosphoresence.

The following are the principal genera:

A. Elytra complete, except in some wingless females; head wholly or partially covered by the thorax.
- B. One or more ventral segments, pale yellow, and luminous in the living insect.
  - C. Antennæ dilated and compressed; the abdominal segments of the males lobed at the sides; the last segment only luminous.......LUCIDOTA, 3 sp.
  - C C. Antennæ slender; the abdominal segments simple; one to three last segments luminous: PHOTINUS, 26.

A A. Elytra much abbreviated and attenuated; head exposed; antennæ branched; phosphoresence uncertain.......PHENGODES, 2.

The *Lucidota atra*, Fab., supposed to be the same as the *laticornis* of the same author, is a common insect. It varies from three to four-tenths of an inch in length, and is of a deep black color, with the margin of the thorax pale yellow. The genus *Photinus*, Laporte, contains most of our lightning beetles. The *P. pyralis*, Linn., (Fig. 48,) is half an inch or a little more in length, blackish, thorax with yellow margin and red disk, with a blackish spot in the center; the elytra have a nar-

* We should perhaps also except the *Fulgora lanternaria* of S. America, and the *F. candelaria*, and the *Buprestis ocellata* of China, and a few other insects which have been reported to possess luminous properties. But the testimony with regard to all of them is very conflicting, even with respect to the first mentioned, the luminousness of which has been generally believed.

row yellowish border, and suture. Mr. Riley has shown that it is luminous in the larva and pupa as well as the perfect state. It is common in the latitude of Southern Illinois; but farther north and east its place is to a great extent supplied by a very similar but much smaller species, the *P. scintillans*, Say. The *P. angulata*, Say, is as large as the *pyralis*, and is distinguished by its generally paler color, the wider yellow margin of the elytra, and by the extreme margin of the thorax being clouded with black. Certain species which (like the *P. pensylvanica*, of DeGeer), have the head but partially covered by the thorax, were placed in a separate group by Dejean, to which the name Photuris was subsequently given by LeConte. The genus is retained by Lacordaire, but it is abandoned by Dr. LeConte himself, in his work on the Classification of the Coleoptera.

The *Lampyris plumosa*, of Olivier, is the type of the remarkable genus *Phengodes*, Hoff. The antennæ are beautifully plumose, and the elytra are abruptly narrowed to a point, and do not extend more than a third the length of the abdomen. It is half an inch long and of a brownish color. Six other species are known which inhabit South America. Lacordaire states that these insects possess luminous properties, but Leconte questions this, as none of the ventral segments exhibit the usual sulphur-yellow color in the dried specimens. In the specimens in my collection, the ventral segments are black in the middle, and fulvous or tawny-yellow at the sides, with a narrowed portion at the base of each segment of a lighter yellow color, and this may possibly be the seat of the phosphoresence.

Sub-family TELEPHORIDES.

In this sub-family the head is usually wholly uncovered by the thorax, and narrowed behind into a short neck. They are more active than the other Lampyridæ, and are often found upon flowers, or running over the surface of leaves in search for their prey, which seems to consist mostly of the soft larvæ of other insects.

A. Head partially covered by the thorax; maxillæ elongated and extensile; elytra yellow with a large black spot or stripe .... CHAULIOGNATHUS, 9 sp.

A A. Head wholly uncovered; maxillæ normal; elytra black, sometimes with a narrow yellow border.

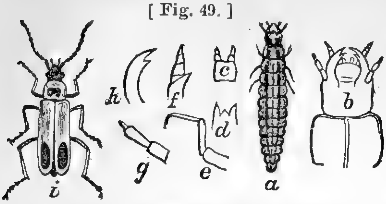
B. Head with a distinct neck; size various .... TELEPHORUS, 72.

B B. Head without visible neck; size small .... SILIS, 3.

The genus *Chauliognathus*, Hentz, is remarkable for the extensile maxillæ, apparently analogous to the elongated maxillæ and labium of bees, with which they lap the honey of flowers. Indeed, the perfect insects are usually found upon flowers, especially those of the golden rod, upon which they have been said to feed; in which case they form an exception to the carnivorous habits of the family in which they are placed. The beetles, however, are furnished with sharp curved mandibles like other Telephorides, and the larvæ are known to be pre-emi-

nently carnivorous. We have two common species of the genus: the *C. pensylvanicus*, DeGeer, (Fig. 49,) with a large oval black spot near the end of each elytron; and the *C. marginatus*, Fab., with a broad black stripe through the middle of the elytron. *Telephorus*, Schæffer, contains many species, varying from less than a quarter to more than half of an inch in length. They are black, with the thorax usually partly or wholly reddish-yellow. *Silis*, Megerle, contains a few small species, less than a quarter of an inch in length, and colored like Telephorus, from which they differ in having the head inserted in the thorax, which is two or three times as wide as it is long, and with a notch on the side and near the posterior angle, usually most conspicuous in the males.

[Fig. 49.]



CHAULIOGNATHUS PENSYLVANICUS, DeGeer:—*a*, larva; *b*, head of larva magnified, showing antennæ, mandibles, and palpi. The small side figures show the same parts still more highly magnified; *i*, beetle—after Riley.

Family XL. MELYRIDÆ.

This is a family of small extent, and is composed mostly of small or very small species. They bear a general resemblance to the preceding family, but are usually smaller and differ in the palpi not being widened at the tip, and in the fourth joint of the tarsi not being bilobed, in both of which characters they differ from the great majority of the soft-winged beetles. The species of the genus Malachius have the singular power of protruding from the sides of their bodies a number of soft orange-colored vesicles, the use of which is a matter of conjecture. They are supposed to be instrumental in deterring their enemies. The larvæ are carnivorous, like those of the other Malacodermes; but the perfect insects are generally found upon flowers, and are supposed to feed upon their more tender parts.

The two leading genera in our fauna are Malachius—which has been divided into a number of sub-genera, all of which possess the extensile vesicles—and Dasytes, in which the vesicles are wanting.

Family XLI. CLERIDÆ.

In this family the labial palpi terminate in a large hatchet-shaped joint, and the fourth joint of the tarsi is bilobed; but the body is tolerably firm, and the antennæ depart from the common serrate character in being more or less widened towards the tip; but the enlargement differs from the genuine clavate, in being more or less flattened, and sometimes strongly serrate. They also differ from the Malacoderms proper in having usually but five segments in the abdomen, whereas the latter have seven. The Cleridæ are usually rather below the me-

dium size, often prettily colored with orange and blue, and their surface is usually more or less pubescent or hairy. They are oblong in form, and the thorax is considerably narrower than the elytra.

These insects are purely carnivorous. The larvæ are sometimes found under the bark of dead trees, in company with the small wood-eating larvæ, upon which they subsist. Others are found in the nests of ants, and still others in the dried carcases of dead animals.

The genera of Cleridæ is as follows:

A. Tarsi 5-jointed; thorax rounded at the sides, without a sharp margin.
  B. First tarsal joint of ordinary length; body much elongated.
    C. Antennæ 10-jointed, the last very long and flat........................ELASMOCERUS, 1 sp.
    C C. Antennæ 11-jointed; serrate but little enlarged at tip.
      D. Eyes finely granulated..TILLUS, 1.
      D D. Eyes coarsely granulated..CYMATODERA, 17.
  B B. First tarsal joint usually small and concealed beneath the second; body moderately elongated.
    E. Eyes notched, and of moderate size; head not wider than thorax.
      F. All the palpi enlarged at the tip; body coarsely punctured and very hairy; antennal club triangular..TRICHODES, 6.
      F F. Only the labial palpi enlarged; body moderately punctured and hairy; antennal club long and loose..CLERUS, 29.
    E E. Eyes very large and entire; head much wider than the thorax........HYDNOCERA, 22.
A A. Tarsi 4-jointed; thorax with a narrow but distinct lateral margin.
    G. Antennæ strongly serrate at the end..ENOPLIUM, 4.
    G G. Antennæ terminating in a 3-jointed flattened club........................NECROBIA, 5.

The genera Clerus and Hydnocera are the most numerous in species, some of which are sufficiently common. *Clerus*, Geoffroy, with which we include *Thanasimus*, Latr., and *Thaneroclerus*, Spin., contains a number of prettily marked species, which are sometimes seen running over prostrate logs in the forest, in search probably of small wood-eating larvæ. The *Clerus dubius*, Fab., is a little more than three-tenths of an inch long, of a steel-blue color, the elytra crossed by three orange bands. The *C. nigrifrons*, Say, is upwards of two-tenths, of a tawny yellow color, the elytra cinereous behind, including a broad black band; there is a black spot on the front, and the venter is black. *C. nigripes*, Say, is very similar, but the frontal spot is wanting and the venter is red. The *C. sanguineus*, Say, is of the same size as the last, with the thorax brown and the elytra scarlet.

The Hydnoceræ are small and obscure insects, less than a quarter of an inch in length, but easily distinguished by their large prominent eyes, which cause the head to be wider than the thorax. They are often beaten from the leaves of forest trees.

The genus *Trichodes*, Herbst, contains a number of very hairy and prettily banded species, the larvæ of which devour the larvæ of certain kinds of bees. Some are found in the nests of the mason-bees, and the European *T. apiarius* has been known to be very destructive to the hive-bee.

The *Necrobia violacea*, Oliv., a small dark-blue or greenish beetle, three-twentieths of an inch in length, has been imported from Europe.

It is sometimes found in houses, but more commonly on the carcases, and especially the bones, of dead animals. The have even been found under the wrappings of Egyptian mummies. The *N.* (*Corynetes*) *rufipes*, DeGeer, has also become spread over the whole globe.

Section II. *HETEROMERA.*

Five joints in the anterior and middle tarsi, and four joints in the hind tarsi, the joints being usually slender and bare, or at most, sparsely haired or spinous.

The Heteromera constitute the second principal division of Coleopterous insects, distinguished primarily, as the name implies, by the diverse number of joints in their tarsi, or feet. This character is remarkably uniform, only two or three exceptional cases having been detected in all the known insects of this section; and as but few of them are of very small size, the number of tarsal joints is usually easily determined. It is also seen by the above formula that the tarsal joints in the insects of this, as of the preceding section, are usually slender and clothed, at most, with scattered hairs or bristles, thus strongly contrasting with the dilated brush-like and bilobed tarsi of the two succeeding sections.

This section embraces an extensive series of beetles, though less numerous than the first and third sections. Although most of them are vegetable feeders, at least in the imago state, comparatively few subsist upon growing plants, and but few, even of these, have been known to increase to such an extent as to become injurious to cultivated crops. The principal exceptions to this statement are the common meal-worms belonging to the genus Tenebrio, and the Lyttæ or Cantharides, which are sometimes seriously destructive to the foliage of vegetables, especially that of the potato.

The Heteromera comprise two very diverse groups of beetles, which have, indeed, scarcely any characters in common except the number of tarsal joints.

The first division, of which the well known Cantharides may be taken as the leading type, is distinguished by having the head wider than the anterior part of the thorax and attached to it by a short neck; by the elytra being comparatively thin and flexible; by their frequently diversified colors; their active diurnal habits; and the parasitic character of many of their larvæ.

The other section, which may be represented by the common black Tenebrio or meal-beetle, is distinguished from the foregoing by having the head partially immersed in the thorax; their hard and inflexible elytra; their obscure and mostly black or brown colors; and by their being vegetable feeders in both the perfect and the larva states.

The first of these divisions contains a considerable number of sufficiently distinct and well marked families; but many of the minor groups

of the second division are so intimately connected by intermediate grades, that Lacordaire and other recent authors have united a large proportion of them in one large family under the name of *Tenebrionidæ*.

In accordance with our plan of classifying insects as nearly as possible according to their habits and the nature of their food, we will divide the Heteromera into four tribes, as follows:

A. Head as wide as the thorax, and attached to it by a visible neck. Body rather soft and elytra flexible; anterior coxæ large, conical and contiguous; colors often diversified. Larvæ mostly carnivorous and many of them parasitic:

Tribe 1st (or 12th), *Parasitic beetles.*

A A. Head without a distinct neck, narrower than the the thorax, and more or less inserted in it; body firm; coxæ never very prominent; colors usually black or brown; habits never carnivorous.

B. Anterior coxæ moderately prominent and nearly or quite contiguous; antennæ slender and filiform; color usually brown, sometimes black. Larvæ live under bark of decayed trees:

Tribe 2d (or 13th.) *Bark beetles.*

B B. Anterior coxæ small, depressed and separate; antennæ usually moniliform, or sub-clavate and perfoliate.

C. Antennæ usually more or less moniliform, and often a little thickened towards the tip, and as long as the head and thorax. Color almost always black; habits terrestrial:

Tribe 3d (or 14th.) *Heteromerous ground-beetles.*

C C. Antennæ usually shorter than the head and thorax, and strongly clavate and perfoliate; head of males often with two horns. Colors brown or dark metallic, sometimes black with red spots. Habits fungivorous:

Tribe 4th (or 5th.) *Heteromerous fungus-beetles.*

TRIBE XII.

PARASITIC-BEETLES.

Heteromera parasitica. TRACHELIDES, Latreille.

The name *Trachelides*, from a Greek word meaning *a neck*, was given to these insects by Latreille to express their most striking character, that of having the head attached to the thorax by a visible neck; whereas in most beetles the head is inserted in the thorax nearly or quite to the eyes. The exceptions to this rule, however, in the Coleopterous order, are not very uncommon, of which the families of Telephoridæ, Lepturidæ, and portions of the Carabidæ, are some of the most conspicuous examples. But the name was intended to contrast them more particularly with the other beetles of the heteromerous section.

The antennæ, in all the Trachelides are of nearly or the same width throughout, sometimes simple or filiform, sometimes serrate, and sometimes pectinate or branched, especially in the males. The elongated coxæ permit great freedom of motion to the legs; and their frequently bright or diversified colors show that they live exposed to the light of the sun. Accordingly we find that in their matured state they are active diurnal insects, often frequenting plants and flowers.

We have designated the insects of this tribe as *parasitic beetles*, a title which preeminently, but not exclusively belongs to them. The term parasite literally means one who sits at the table of another, and lives at his expense, and is now very commonly applied to those insects which either inhabit the nests of other insects and subsist upon the food prepared by them, or which infest the bodies of other insects, feeding upon their substance, and ultimately causing their death. This parasitism is found to be very extensive in the insect world, and to constitute one of the most efficient agencies by which the excessive increase of many kinds of insects is kept in check. The great majority of parasitic insects is found in the order of Hymenoptera, where they comprise some of the most numerous of the families of insects. In the order of Coleoptera the parasitic species are comparatively few, and outside of the present tribe, are mostly limited to a small number of minute species in the families Staphylinidæ, Pselaphidæ and Scydmænidæ. The parasitic character is therefore the more distinctive of the present tribe, most of the families of which are parasitic in their larva state; though it is pretty well determined that a few of them are lignivorous, and the larvæ of some of the families are but little known. The Lagriidæ and Anthicidæ, from certain observations which have been made upon them, are supposed to be carnivorous, and Latreille considered the latter to be parasitic. The Rhipiphoridæ, Stylophidæ, and Meloidæ, including the subfamily of Horiides, are known to be parasitic. The larvæ of the Pyrochroidæ and Mordellidæ are found in wood, upon which, therefore, they are supposed to feed. Mr. Riley has found the *Mordella 8-punctata*, and its larvæ, (Fig. 50) in very rotten oak stumps, and he states there can be no doubt of its lignivorous habits, as he has found the larvæ in their own burrows, extending through the wood in all directions. He has likewise bred a smaller species from the green stems of ambrosia, and other herbacious plants. In a strict classification according to the habits, therefore, the Pyrochroidæ and Mordellidæ would require to be separated from the parasitic families, but there appear to be no organic characters which these two families possess in common, which authorizes us in placing them in a tribe by themselves.

It is one of the many remarkable facts in the natural history of insects that the same species often differs greatly in its habits and the nature of its food, in the different stages of its existence. We have had occasion

to refer to some of the most common instances of this change in the introductory part of this work, and the same is strikingly illustrated in the history of the present tribe, in which the same species is often parasitic in its larva state, whilst it feeds upon the flowers or foliage of plants in its perfect or imago state.

The following is a table of the families of the Trachelides:

A. Constriction of the neck gradual and slight; anterior coxal cavities closed behind.* Size medium.. ....LAGRIIDÆ.
A A. Neck distinct and abrupt; anterior coxal cavities always open behind.
B. Thorax with a lateral margin; abdomen usually tapering to a long point; hind legs long and flat. Size small...............................MORDELLIDÆ.
B B. Thorax rounded at the sides; abdomen not pointed.
C. Tarsal claws deeply cleft. Size large or medium.................MELOIDÆ.
C C. Tarsal claws entire.
D. Thorax narrower behind than the elytra.
E. Antennæ almost always filiform and simple. Size very small. ANTHICIDÆ.
E E. Antennæ usually branched in the male, serrate in the female. Size medium or small.................................PYROCHROIDÆ.
D D. Thorax as wide behind as the elytra. Size small.......RHIPIPHORIDÆ.
A A A. Without visible neck—structure very abnormal. Size very small. STYLOPIDÆ.

Family XLII. LAGRIIDÆ.

This family is comprised of a small number of medium sized beetles, which furnish a connecting link between the Trachelides and the Tenebrionidæ; having an imperfect neck, and being rather soft and flexible like the former, but having the anterior coxal cavities closed behind, like the latter. Mr. Westwood states that he has found the larva of the European *Lagria hirta* on white thorn hedges; and Lyonet mentions having discovered the same under dead leaves upon the ground.

There are but five N. A. species of this family. The *Lagria (Arthromacra) ænea*, Say, is an elongate brassy-black beetle, nearly half an inch in length, and easily recognized by the remarkably elongated terminal joint of the antennæ, which is as long as the four preceding joints taken together.

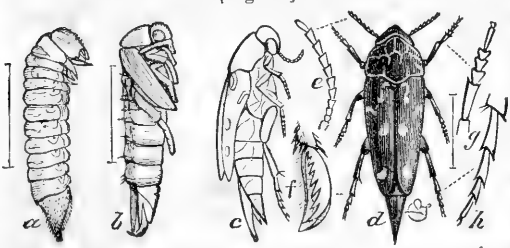
Family XLIII. MORDELLIDÆ.

This family contains a considerable number of small beetles, rarely more, and usually less than a quarter of an inch in length, and distinguished by their elliptical and arched form, the head being bent down

* The state of the anterior coxal cavities as respects their being closed or open behind, is a character of considerable importance in classifying the Coleoptera, especially the Heteromera. The coxal cavities are the hollows in the sternum or breast plate in which the legs are inserted. The anterior cavities are sometimes wholly surrounded by the crust of the sternum, when they are said to be closed; in other cases there is a deficiency of the sternum directly behind the anterior coxæ, which is filled by membrane, and the cavity is then said to be open.

much below the level of the thorax, and by the abdomen usually terminating in a considerably prolonged point. They are, moreover, the only Trachelides which have the upper part of the thorax separated from the lower, on the sides, by a prominent line or margin. The tarsal claws are small, but when strongly magnified they are usually found to be prettily serrated on their lower edge. Their colors are mostly black or slate color, but some of them are slightly variegated with whitish or rufous. The perfect insects are usually found upon flowers, and some of the species are very common. The larvæ have been found in the rotten wood, and in the pith of various plants, upon which they are therefore supposed to feed; and we have already referred to Mr. Riley's observations upon the larvæ of *M. 8-punctata*, which he found in old oak stumps, under circumstances which seemed to preclude the supposition of their being otherwise than lignivorous in their diet.

[Fig. 50.]



MORDELLA 8-PUNCTATA, Fab.:—*a*, larva; *b*, pupa; *c*, beetle, outline side view of female; *d*, dorsal view of same; *e*, antenna; *f*, the serrated tarsal claw of same, highly magnified—after Riley.

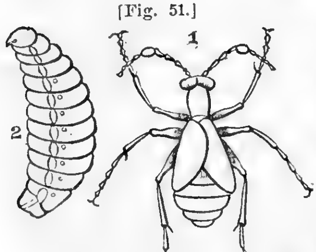
It would seem, therefore, that in a natural classification of the Coleoptera according to their food-habits, the Mordellidæ should be separated from the parasitic Trachelides, and united with the heteromerous bark-beetles, which they also resemble in some of their organic characters, such as their proportionally smaller heads, margined thorax, and sombre colors. In this case their location would be adjoining the Cistelidæ, which they resemble in the peculiar character of their serrated claws.

There are upwards of ninety described N. American species of this family, most of which are contained in genera Anaspis and Mordella, the former being distinguished by not having the abdomen prolonged to a point.

Family XLIV. MELOIDÆ.

This family contains the well-known Lyttæ or Cantharides. They have elongated flexible bodies, with a very distinct neck, and with the claws deeply cleft, the upper portion being often pectinate, or comb-toothed. They are rather large or medium-sized insects. Our most common species are blackish or ash-colored, but some are prettily striped, and others are richly variegated with green and yellow. The larvæ, so far as known, are

[Fig. 51.]



MELOE:—1, male beetle; 2, larva—after Packard.

parasitic in the bodies or in the nests of bees. Their history was long involved in obscurity, but the development of the larvæ of the genus Meloe has been satisfactorily elucidated by Newport, Siebold and other modern observers. It appears that the parent beetles deposit their eggs in the nests of various kinds of bees, but especially those of the humble-bees. The young larvæ are sometimes found in the nests, but usually upon the bodies of the bees, from which they draw their nutriment. Infested bees, observed in confinement, have been seen to become exhausted by these larvæ, thus proving them to be genuine parasites. The following are the principal genera:

A. Elytra much shorter than the abdomen, separate at their tips, and usually lapping one upon the other at base .... MELOE, 14 sp.

A A. Elytra covering the abdomen.

B. Head large, front not prolonged beyond the base of the antennæ; frontal suture wanting: HORIA, 3.

B B. Head moderate, front somewhat prolonged, and with a distinct suture.

C. Mandibles long and acute; maxillæ greatly elongated .... NEMOGNATHUS, 28.

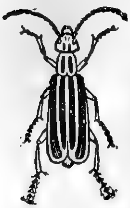
C C. Mandibles short and obtuse; maxillæ norman .... LYTTA, 99.

The genus *Meloe*, Linn., is alluded to by Kirby as apparently forming a connecting link between the Coleoptera and the Orthoptera, having the head vertical, and the elytra lapping at base, but the resemblance is very remote. The inferior or true wings are wanting, and these insects are found on the ground, where they feed upon herbaceous plants, mostly those of the genus Ranunculus. The females become so swollen with eggs that they drag their abdomens with difficulty along the ground. When captured they exude a yellow oily fluid from the joints of their legs, whence they have received the popular name of *oil-beetles*. They vary in length from half an inch to an inch, and are either black or of a dark violet-blue color. Our most common species is the *Meloe angustacollis*, Say, of a violaceous color, the female upwards of three-quarters of an inch in length; the male is considerably smaller, and has the antennæ remarkably swollen and knotted in the middle.

We have two species of the genus *Horia*, Fab., both of which are extremely rare. They are found in ants' nests. The *H. sanguinipennis*, Say, is four-tenths of an inch long, black, with light red elytra.

The genus *Nemognatha*, Illiger, is remarkable for the elongation of the outer lobe of the maxillæ into a long setaceous proboscis, very similar in appearance to that of the honey-bees in the hymenopterous order. These insects are found on flowers, the honey of which they probably extract. We have seen a somewhat similar structure to exist in the genus Chauliognathus, in the family of Telephoridæ; but here the organ is soft and elastic, and capable of being retracted within the cavity of the mouth.

[Fig. 52.]



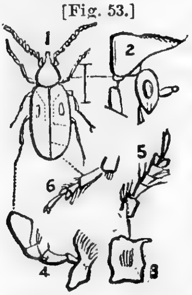
LYTTA VITTATA, Fabricius.

The genus *Lytta*, of Fabricius, or *Cantharis*, of Geoffroy, contains the blistering beetles of the shops, and also the well-known ash-colored, black, and striped potato-beetles. Some entomologists divide them into two groups or subgenera: *Lytta* proper, in which the antennæ are almost moniliform, and a little thicker towards the tip, and *Epicauta*, in which the antennæ are filiform, or a little tapering, with the joints elongated. The latter group contains all our common species.

Family XLV. ANTHICIDÆ.

This family, founded upon the genus *Anthicus*, a Greek word, meaning *variegated*, is of moderate extent, and is composed of very small, prettily colored beetles, never much exceeding an eighth of an inch in length. They are readily distinguished from most other small beetles by their narrow necks. Some of them bear a striking resemblance to ants, and others are remarkable for a prominent horn on the top of the thorax. The larvæ are unknown, but some observations of Latreille led him to believe that they are parasitic. The perfect insects are found on flowers and leaves.

[Fig. 53.]



NOTOXUS:—1, beetle; 2, front of body seen laterally; 3, mandible; 4, maxillary palpus; 5, 6, tarsi—after Westwood.

Most of our species are found in the three following genera:

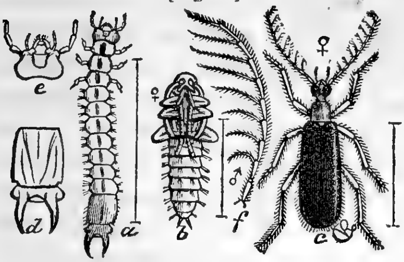
A. Eyes notched, hairy, and coarsely granulated........XYLOPHILUS, 6 sp.
A A. Eyes oblong and entire.
B. Thorax prolonged over the head in the form of a horn........NOTOXUS, 15.
B B. Thorax without horn........ANTHICUS, 50.

The curious little *Notoxus monodon*, Fab., is not an uncommon insect. It is of a brownish-yellow color, with a black band across the middle of the elytra, and two spots of the same at the base, and an obscure one at the tip. The horn on the thorax projects forwards so as to cover the head. Another, but less common species, is the *N. bicolor*, Say. The head and thorax are yellowish, and the elytra are blue-black. The genus Anthicus is much the most numerous in species.

Family XLVI. PYROCHROIDÆ.

The species of this family are few in number, and are most conspicuous for the usually branched antennæ and their common style of coloration, which is that of a red thorax contrasted with the black elytra. They are of medium size, varying from one-third to three-fourths of an inch in length. The name is derived from the genus *Pyrochroa* of Geof-

[Fig. 54.]



DENDROIDES CANADENSIS, Latr.:—*a*, larva; *b*, pupa; *c*, beetle (female); *d*, enlarged anal horns; *e*, enlarged head of larva; *f*, antenna of male magnified—after Riley.

froy, a word which means *flame colored*, and which was obviously suggested by the prevalence of red or yellow in their coloration; some of the foreign species being almost wholly red. An example of the larvæ is exhibited in the accompanying figure of the larva of Dendroides. These larvæ are found under the bark of decayed trees and stumps, and are supposed to be lignivorous.

The following are the three principal genera:

A. Antennæ flabellate or pectinate.
B. Eyes very large, nearly contiguous.......DENDROIDES, 4 sp.
B. B. Eyes moderate and distant.......PYROCHROA, 2.
A. A. Antennæ simple.......PEDILUS, 14.

The *Pyrochroa flabellata*, Fab., is from five to six-tenths of an inch in length, of an elongated and somewhat flattened form with parallel sides. The head and thorax are yellow, and the elytra blue-black. The *Denroides canadensis*, Latr. (Fig. 54) is somewhat similar but a little smaller and the elytra are of a dull or brownish-black color. Both of these insects are rather common about decayed trees, under the bark of which the larvæ reside. The antennæ are flabellate in the males, and pectinate in the females. The species of *Pedilus* are mostly between two and three-tenths of an inch in length, and usually exhibit the reddish thorax and black elytra, so characteristic of the family.

Family XLVII. RHIPIPHORIDÆ.

This is a small family the species of which are distinguished by having the elytra usually shorter than the abdomen, and somewhat narrowed and separated from each other behind. the thorax is narrowed in front, but as wide at base as the elytra, in which they differ from all the other Trachelides except the Mordellidæ, with which they are united by some authors. But the different habits of the larvæ confirm the propriety of their separation. The perfect insects are found on flowers. The larvæ are parasitic in the nests of wasps, and a foreign species is known to infest the bodies of cockroaches.

Twenty-two N. A. species have been described.

Family XLVIII. STYLOPIDÆ.

A family of minute insects of so anomalous a character that it is very difficult to determine their proper location in the natural system. But few species are known, all of which are parasitic in the bodies of bees. Five genera have been described, two of which have been found in N.

America: *Stylops*, Kirby, with the antennæ six-jointed; and *Xenos*, Rossi, having the antennæ four-jointed. For a detailed description of these insects the reader is referred to Westwood's Introduction, Vol. II, page 287; or to Packard's Guide, page 481.

Tribe XIII.

HETEROMEROUS BARK-BEETLES.

Heteromera corticicola. STENELYTRA *partly*, Latreille.

This tribe includes all the Stenelytra of Latreille except the family of Helopidæ, which are now united to the Ground-beetles. The word *Stenelytra* means having *narrow wing-covers*, and was given to these insects on account of their more or less elongated and narrow forms. They are distinguished from the parasitic beetles by the absence of a visible neck and by the head being narrower than the thorax; and from the two following tribes by the usually longer and more slender antennæ, by the anterior coxæ nearly or quite touching each other, and by their coxal cavaties being open behind, except in Cistelidæ where they are slightly closed. The larvæ of all these insects are found under the bark or in the decayed wood of trees which have been long dead. The perfect insects are generally found in the same situations, but some, especially the Cistelidæ, are often seen upon leaves or flowers.

The following are the families of bark-beetles:

A. Thorax rounded at the sides, or without a sharp lateral margin, narrower behind than in front, and narrower at base than the elytra.
- B. Head gradually narrowed behind, and usually somewhat prolonged in front; last joint but one of tarsi slightly bilobed................ŒDEMERIDÆ.
- B B. Head not narrowed behind; sometimes prolonged in front into a snout; tarsi entire...PYTHIDÆ.

A A. Thorax with a lateral margin, not narrowed behind, and usually as wide at base as the elytra.
- C. Maxillary palpi terminating in a hatchet-shaped joint; claws serrate: CISTELIDÆ.
- C C. Maxillary palpi usually long and pendulous, with all their joints more or less enlarged; claws simple....................MELANDRYIDÆ.

Family XLIX. ŒDEMERIDÆ.

A small family of heteromerous beetles, with elongate, narrow bodies, the head and thorax somewhat narrower than the elytra, and rather long filiform antennæ. The elytra in some of the foreign species are narrowed and separated behind. Our most conspicuous species is the *Nacerdes melanura*, which is more than half an inch in length, of a yellowish-brown color, with the elytra tipped with black.

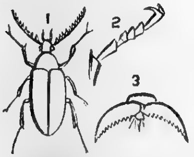
Family L. PYTHIDÆ.

Another small family containing less than a dozen North American species, the most remarkable of which belong to the genus Salpingus, which differs from all other Coleoptera except the Curculionidæ, in having the head prolonged in front in the form of a snout, sometimes of considerable length. The two leading genera are *Pytho*, Latr., and *Salpingus*, Illiger.

Family LI. CISTELIDÆ.

This is a family of considerable extent, and some of the species are amongst our most common insects. They are smooth, oval beetles, of moderate or rather small size, and are generally clothed with minute hairs, which give a silken gloss to the surface. Their most distinctive character is the pectinate or comb-toothed claws at the end of the tarsi. This, like most other minute characters, can be best seen by holding the insect up against the light of a window and examining it through a lens. This character is very rare in the Coleoptera, and therefore quite distinctive where it occurs. We have already seen it to exist in the genus *Lebia* and a few other Carabidæ, and a modification of it occurs in the families Meloidæ and Mordellidæ.

[Fig. 55.]



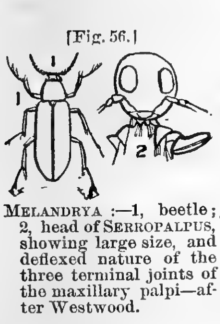
CISTELA:—1, beetle; 2, tarsus; 3, tarsal claw—after Westwood.

Our most common species of Cistelidæ are plain, brownish beetles without spots. Thirty-five species have been described, most of which are contained in the genera *Cistela** and *Allecula* of Fabricius; the former having merely simple tarsi and the latter having the anterior tarsi somewhat dilated, and all of them with the penultimate joint bilobed.

Family LII. MELANDRYIDÆ.

The insects of this family were called Serropalpi by Latreille, to express their most remarkable character: that of having the joints of the maxillary palpi—which are usually long and pendulous—more or less enlarged in the form of saw-teeth, the last joint being the largest, and usually hatchet-shaped. It is a family of moderate extent, containing forty-five N. A. species. They never much exceed half an inch in length, and some are less than half that

[Fig. 56.]



MELANDRYA:—1, beetle; 2, head of SERROPALPUS, showing large size, and deflexed nature of the three terminal joints of the maxillary palpi—after Westwood.

* This name—derived from the Greek *kiste*—a *chest*, appears to have been given originally by Geoffroy to the insects of the genus *Byrrhus*, Linn., to the short and thick bodies of which it was not inapplicable. But Linnæus having given the name Byrrhus to this genus, the name Cistela was transferred by Fabricius to the present group of heteromerous beetles, where it has now become established by general acceptance and long usage.

length. Their colors are black or brown, and some of those of the latter color are ornamented with yellow markings.

The following are the principal genera:

A. Head without a neck.
  B. Antennæ with the four last joints abruptly enlarged .... TETRATOMA.
  B B. Antennæ filiform or slightly and gradually enlarged.
    C. Anterior coxæ contiguous.
      D. Middle coxæ contiguous, with distinct trochantins .... MELANDRYA.
      D D. Middle coxæ separate, without trochantins .... SERROPALPUS.
    C C. Anterior coxæ separate.
      E. Head horizontal .... SYNCHROA.
      E E. Head vertical .... EUSTROPHUS, HALLOMENUS, ORCHESIA.
A A. Head with a short neck; eyes coarsely granulated and deeply notched .... SCRAPTIA.

We have space to refer to only a few of the most noticeable species. We have two species of Tetratoma, which depart from the ordinary habits of the family by being inhabitants of fungi. The *Melandrya striata*, Say, is six-tenths of an inch long, pure black, the thorax with a middle furrow, and a depression on each side, and the elytra deeply striate and punctate. *Serropalpus 4-maculatus*, Say, is a third of an inch in length, of a deep brown color, with two angular yellow spots on each elytron. *Hypulus trifasciatus*, Melsh, is quarter of an inch or less in length, yellow, with three irregular brown bands across the elytron. These, like the other species of the family, are found under the loose bark of trees in an advanced state of decay. One of the most common larvæ found in such situations is that of the *Synchroa punctata*, Newm., a plain light-brown species about half an inch in length. This larva is of an elongate cylindrical form, with six short legs, and two horny points at the posterior extremity of the body.

The genus *Penthe*, of Newman, is placed in this family by LeConte, but in the sub-family of Helopides by Lacordaire. The palpi are rather long and robust, but not hatchet-shaped at the end like most of the Serropalpi. It contains two rather large, oval, depressed beetles, upwards of half an inch in length, and of a deep black color: the *P. obliquata*, and the *P. pimelia*, of Fabricius; the former being distinguished by having the scutellum clothed with rust-red hairs. They are common species, being found under the bark of decayed trees and in rotten stumps. Their sub-cortical habits furnish an argument for retaining them in the present tribe.

TRIBE XIV.

HETEROMEROUS GROUND-BEETLES.

Heteromera terricola. MELASOMA, Latreille.

This tribe contains a large and diverse assemblage of beetles, distinguished chiefly by their heteromerous tarsi, their usually slightly cla-

vate and moniliform antennæ, and their uniformly dark or black coloration. The above name of Latreille, meaning *black-bodied*, is expressive of this character. As a general rule they are rather large beetles, many of them being above the medium size, and few much below it. They are found almost exclusively upon the ground, and mostly in sandy situations. Scarcely any observations appear to have been made respecting the food-habits of these beetles, with the exception of a few common species which inhabit houses and granaries, the larvæ of which are sometimes seriously injurious to flour and meal of different kinds. The larvæ of a few species have been found in rotten wood. All the known larvæ are very similar in form and structure, and are well represented by the common meal-worm which is the larva of the *Tenebrio molitor*, Linn. This is a long, slender, cylindrical grub, of a wax-yellow color, and a hard consistency. In its motions it seems to drag its body along by means of the six short legs attached to the three anterior segments, its comparative inflexibility incapacitating it for the vermicular motion by which the softer larvæ effect their progression.

A comparatively small proportion of the insects of this tribe inhabit the northern and eastern sections of this country. Their geographical center is in the tropics, and they constitute a leading feature in the insect fauna of California, and other portions of the Pacific slope.

The several groups of which this tribe is composed are found to pass so insensibly into each other, when the species from all parts of the world are compared together, that Lacordaire, in his great work on the genera of Coleoptera, unites them all in the one large family of Tenebrionidæ, in which he also includes the fungus-beetles (*Diaperidæ*). In this course he has been followed by our own distinguished coleopterist, Dr. John L. LeConte, and more recently by Dr. George H. Horn, of Philadelphia, who has published an elaborate monograph of the N. A. species of this family.

In speaking of the unusual difficulties which are met with in classifying this tribe of insects, M. Lacondaire makes some remarks which are so pertinent to the case, and at the same time so comprehensive, that we here introduce them:

"Our classifications of insects are based, not upon isolated characters, but upon combinations of characters. In order that they may admit of easy application it is necessary that the characters thus combined shall be neither too many nor too few. There are some families, such as the Elateridæ, where the latter is the case; they are too homogeneous. Others, even more numerous, as the Carabidæ, for example, hold a just medium in this respect; their species possessing a common basis of organization which is stable, or which varies but little. We here, therefore, have to deal with a restricted number of organs, which admit of

—16

only a moderate quantity of combinations. From this it results that the groups superior to genera can be characterized in a few words, and their limits are, in general, sufficiently well defined. With the Tenebrionidæ, on the contrary, an instability without limit is the rule; not a single organ, even the most insignificant, escapes. If, as we ought, we take all of them into account, the number of combinations to which they give rise is so great that it is impossible to bring any of them to the front, and for each group we are obliged to pass in review almost the entire organization. If to this we add the insensible transitions between the forms of organs which are themselves equally unstable, we shall understand how the groups thus constituted absolutely refuse to admit of any precise definition." Vol. V, p. 289.

But, notwithstanding the difficulty of dividing this tribe into minor groups by any sharp lines of demarkation—a difficulty which we are continually encountering, in a greater or less degree, in all our attempts at generalization in natural history—they may still be arranged in several divisions which will facilitate the determination of species. Thus regarded, this tribe will constitute the family of Tenebrionidæ, which can be divided into several minor groups which will take the rank of sub-families.

Family LIII. TENEBRIONIDÆ.

This family having been already sufficiently described in treating of the tribe which it constitutes, we proceed to designate the sub-family into which it may be divided:

A. Antennæ longer than the head and thorax united, slender and of nearly or quite the same width throughout; front separated from the labrum by a membranous clypeus; body often with a metallic or brassy tint..........HELOPIDES.

A A. Antennæ usually about as long as the head and thorax united; gradually enlarging towards the tip, and with the joints usually more or less round or moniliform; front articulating directly with the labrum; color black: TENEBRIONIDES.

A A A. Antennæ usually shorter than the head and thorax united, with joints wider than they are long, or more or less perfoliate; middle coxæ without trochantins; color generally brown..............................ULOMIDES.

Sub-family HELOPIDES.

The name Helops appears to have been originally given to a harmless species of serpent, but was appropriated by Fabricius to a sub-division of the coleopterous genus Tenebrio, of Linnæus. We use the family name here in a comprehensive way to include a considerable number of species distinguished from the Tenebrionidæ proper by the characters given in the foregoing table. The larvæ resemble those of Tenebrio,

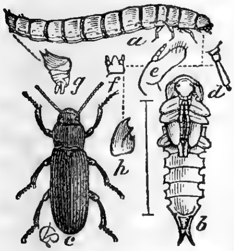
and are found in rotten wood. The perfect insects are sometimes found upon the ground. They are usually of a medium size. The following are the principal genera:

A. Lateral and anterior margins of the front continuous; body oval; sides of the breast beneath, often striated longitudinally.................HELOPS, 24 sp.
A A. Lateral margin of the front elevated, oblique, and abbreviated.
B. Body elongated.................STRONGYLIUM, 2.
B B. Body very convex.................MERACANTHA, 1.

Sub-family TENEBRIONIDES. *Darkling beetles.*

Founded upon the genus Tenebrio, of Linnæus, a name derived from the Latin *tenebræ*, meaning *darkness*, and given to these insects on account of their universally black color. The family is very extensive, but, as formerly remarked, the great majority of N. American species inhabit the western slope of the continent, but some species are found in great abundance upon the arid plains which extend eastward from the base of the Rocky mountains. The typical and most common species is the *Tenebrio molitor*, a plain black beetle, six-tenths of an inch in length, whose hard, wax-colored larva is often found upon the floor where grain and meal are stored. Most of these insects are found on the ground, but some live under the bark of fallen and decaying trees. The following are some of the principal genera:

[Fig. 57.]



TENEBRIO OBSCURUS, Fab.:—*a*, larva; *b*, pupa; *c*, beetle; *d*, antenna of larva; *e*, maxilla; *f*, labium; *g*, terminal segment, showing the dual proleg fully extended, of same—after Riley.

A. Ventral segments entirely horny; tarsi spinous beneath.
B. Middle coxæ without trochantins.................ZOPHERUS.
B B. Middle coxæ with distinct trochantins.
C. Thorax transversal, its hind angles prominent and embracing the base of the elytra.....ASIDA.
C C. Thorax heart-shaped, its hind angles not prolonged.................PELECYPHORUS.
A. A. Ventral segments 3 and 4 with the hind margin membranous.
D. Elytra embracing widely the sides of the abdomen; tarsi bristly beneath..BLAPS. ELEODES.
D D. Elytra not embracing widely the sides of the abdomen.
E. Eyes divided in two by the margin of the head; tarsi bristly beneath.........BLAPSTINUS.
E E. Eyes not divided.
F. Tarsi with a silky golden pubescence beneath.................UPIS.
F F. Tarsi with coarse pubescence.................TENEBRIO.

The general remarks made in describing the present tribe, apply particularly to the numerous species of this sub-family.

Sub-family ULOMIDES.

This sub-family includes a small number of heteromerous beetles, which are closely allied to the Tenebrionides in their general characters, but differ from them chiefly in their shorter and more or less perfoliate antennæ, the absence of trochantins in their middle legs, and their usually reddish-brown color. The anterior tibiæ are more or less dilated, and sometimes toothed on the outer edge, and the last tarsal joint

is often as long as all the others united. They are mostly found under the bark of dead or decaying trees. The larvæ of some foreign species of Uloma have been found in flour and in bake houses, like those of Tenebrio proper. The species of the genus Hypophlœus, as the name implies, live under the bark of trees. These, which are our two most common and typical genera, may be thus distinguished:

A. Labrum attached directly to the front; anterior tibæ dilated and toothed on the outer edge; size about medium .... ULOMA.

A A. Labrum separated from the front by a membranous clypeus; anterior tibæ somewhat widened but without teeth; size small .... HYPOPHLŒUS.

Uloma contains five N. American species. The *U. impressa*, Melsh, is a common insect, found in old logs and stumps in an advanced stage of decay. It is between four- and five-tenths of an inch in length, and of a deep mahogany-brown color. It was formerly considered identical with the *U. culinaris* of Europe. The *U. imberbis* and the *U. punctulata*, Lec., are similar, but only about three-tenths of an inch long, and of a lighter color. The former is distinguished by having the last joint of the antennæ obliquely truncated and pointed. The other two species have not been found east of the Mississippi river. Hypophlœus contains three species. They resemble Uloma in form and color, but are only about three-twentieths of an inch in length.

TRIBE XV.

HETEROMEROUS FUNGUS-BEETLES.

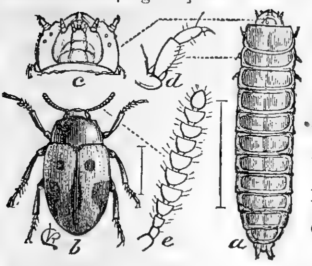
Heteromera fungicola. TAXICORNES *mostly*, Latreille.

The insects of this small tribe so closely resemble the heteromerous ground beetles in their organic details, that they are merged by Lacordaire in his comprehensive family of Tenebrionidæ. They are, however, usually easily distinguished by their general form and color, and their short perfoliate antennæ, besides the other characters mentioned in the general description of the tribes of the heteromerous section. But they are especially distinguished by their fungivorous habits. The only other insects in this section which are known to us, in this country, having similar habits, are the two species of Tetratoma, in the family of Melandryidæ.

They are usually found, in all their stages, in the fungi which grow upon trees; but they are sometimes found under decayed bark, where they are supposed to feed upon the small fungi which grow in such situations. They comprise the family Diaperidæ.

Family LIV. DIAPERIDÆ.

[Fig. 58.]



DIAPERIS HYDNI, Fabr.:—*a*, larva; *b*, beetle; *c*, underside of head of larva; *d*, leg of same; *e*, antenna of beetle—after Riley.

This small family is founded upon the genus *Diaperis*, of Geoffroy, a term derived from a Greek word meaning *to pass through*, and suggested probably by the perfoliate character of the antennæ, in which the axis appears to pass through the dilated joints; or, the name may have had reference to the habits of the larvæ, in perforating the fungi upon which they feed. The short and more or less perfoliate character of the antennæ, distinguishes these insects from all the other Heteromera except the sub-family of Ulomides. Their other leading characters have been already described in speaking of the tribe which they constitute. The following are the principal genera:

A. Body somewhat square-shaped and rough. First joint of tarsi very short. (Sub-family *Bolitophagides*) .... BOLITOPHAGUS, 4 sp.

A A. Body oval and smooth. First joint of tarsi usually longer than the second. (Sub-family *Diaperides*.)

- B. Antennæ shorter than the thorax, and perfoliate. Last joint of maxillary palpi elongated.
  - C. Head unarmed. 1st joint of hind tarsi as long as the 2d. Length of body quarter of an inch or upwards. Colors black, with reddish-yellow spots .... DIAPERIS, 2.
  - C C. Head of the males usually with two horns or tubercles. 1st joint of hind tarsi as long as 2d and 3d united. Length less than ¼ inch. Color black or bronzed green, without spots. Thorax sometimes red .... HOPLOCEPHALA, 2.
- B B. Antennæ longer than thorax, almost moniliform. Last joint of maxillary palpi triangular. First joint of tarsi longer than 2d and 3d. Surface often pruinose or mealy; usually without spots .... PLATYDEMA, 14.

The *Bolitophagus cornutus*, Panzer, is one of our most remarkable insects. It is a thick-bodied beetle of a dark wood-brown color, and a rough or tuberculated surface, and varying from less than four to nearly five-tenths of an inch in length. The male is distinguished by two flattened horns on the top of the thorax, which curve forwards, and which are clothed on the under side with an orange pubescense. It is often found under the bark of old stumps and prostrate logs. The genus Diaperis proper is represented in this country by the *D. hydni*, Fab., (Fig. 58,) which is common throughout the Middle and Eastern States. One other species, the *D. rufipes*, Horn, is found in Arizona. *Hoplocephala*, a term meaning *armed head*, in allusion to the horns on the heads of the males, contains two species: the *bicornis*, Oliv., wholly of a metallic-green color, and the *viridipennis*, Fab., similar, but with a red thorax. They are both a tenth of an inch long, or a little more. As the former is described as sometimes having a brownish thorax, it is probable they are only varieties of the same species. *Platydema* contains fourteen species, as indicated in Dr. Horn's Revision of N. A. Tenebrionidæ, of which the four following are the most common: the *americanum* and

excavatum are shining black species, the latter being distinguished by two short horns on the head of the male; the *flavipes* is known by its bluish pruinose surface and yellow legs; and the *elipticum*, common in the Southern States, which is readily distinguished by the oblique red spot on the anterior part of each elytron.

Section III. *TETRAMERA.*

Apparently four joints in all the tarsi; the joints dilated and brush-like beneath, with the penultimate usually bi-lobed.

The structure of the tarsi in this section is very uniform, being always composed of four distinct joints, with a faint rudiment of the missing joint at the base of the last. We have seen above that in some very small species of the pentamerous section, one or more of the tarsal joints are rudimental or wanting; but it is a curious fact, which may have some important bearing in the classification of these insects, that in the small Pentamera with deficient tarsi, it is usually the first joint which is in a rudimental state, whilst in the genuine Tetramera it is always the fourth joint that is undeveloped. The joints are dilated and cushioned beneath with a dense brush of hairs (except the Scolytidæ), and the last joint but one is almost always bi-lobed, with the last joint inserted between the lobes. But in some of the Chrysomelides proper, the penultimate joint, though dilated as usual, is entire or only slightly notched at the end. The dilated, cushioned and bi-lobed tarsi are peculiar to the beetles of this section with a few exceptions, and therefore serve readily to distinguish them, independently of the number of tarsal joints. This structure of the feet, as we have elsewhere remarked, seems to be specially adapted to enabling these insects to adhere to the surface of leaves and smooth bark, and accordingly all the numerous species of this section are vegetable feeders. Many of them feed upon foliage, some bore into the trunks or branches of trees, and others feed upon fruits or seeds. This section, therefore, embraces a greater number of species injurious to the agriculturist, than all the other sections combined.

The larvæ vary considerably in the different tribes, and will be described in their proper connections. It may be stated generally, that in those which reside in wood or in fruits the feet are usually wanting, or at most are merely rudimental, whilst those which live upon the surface of leaves have six small but well developed feet.

The beetles with four-jointed feet are divided into four tribes, as follows:

Tribe 1st (or 16th of the whole number). Snout-beetles or Weevils. *Fructivora rostrata.* RHYNCOPHORA, Latreille. Head more or less pro-

longed into a snout. Antennæ usually capitate, rarely serrate or filiform. Larvæ mostly fructivorous. Families: Bruchidæ, Anthribidæ, Brenthidæ, Curculionidæ.

Tribe 2d (or 17th). Short-horned Wood-borers. *Lignivora brevicornia.* XYLOPHAGA, Latreille. Head without snout; body short and cylindrical; antennæ clavate or capitate, but little longer than the head; larvæ lignivorous. Family: Scolytidæ.

Tribe 3d (or 18th). Long-horned Wood-borers. *Lignivora longicornia.* EUCERATA, Westwood. Body elongated; antennæ long and tapering, usually longer than head and thorax. Larvæ lignivorous. Family: Cerambycidæ.

Tribe 4th (or 19th). Tetramerous Plant-beetles. *Herbivora tetramera.* PHYTOPHAGA, Kirby. Body usually short and rounded; antennæ filiform or slightly and gradually enlarged toward the end. Larvæ herbivorous. Family: Chrysomelidæ, including the sub-families Criocerides, Galerucides, Eumolpides, Chrysomelides, Cryptocephalides, Hispides and Cassidides.

TRIBE XVI.

SNOUT-BEETLES, OR WEEVILS.

Fructivora rostrata. RHYNCHOPHORA, Latreille.

This tribe of beetles, most of which are comprised in the family of Curculionidæ, is supposed to be the most numerous in species, not only in the class of insects, but in the whole animal kingdom. The only question of the correctness of this estimate would be with respect to some of the families of microscopic animalcula, but here the superiority in number would probably be found to be in individuals only, and not in distinct species. The number of species of Curculionidæ, specimens of which actually exist in the collections of Europe and of this country, does not vary much from 20,000. The number of North American species enumerated in Mr. Crotch's check list of 1873, is 414; and this catalogue undoubtedly falls far short of the whole number, especially of the smaller species.

The prolongation of the head anteriorly, in the form of a slender snout, generally serves to distinguish the beetles of this tribe from all others. But in a considerable number the snout is so short and broad as not to afford a very distinguishing feature. In cases of doubt, therefore, the student must take other characters into account. The most important of these is the usually rudimental state of palpi, and the four-jointed, cushioned, and bilobed tarsi. The antennæ, in the great majority, are knobbed at the end, and geniculate or bent like an elbow near the middle.

The Curculionidæ are generally small beetles, probably not averaging more than a quarter of an inch in length, and a great number being less than half this length. A few of the tropical species, however, are amongst the giants of the beetle tribe, some of them attaining a length of from one to two inches.

The larvæ are soft, white, footless grubs, and almost always inhabit the substance of plants, more especially the fruit in its various forms of seeds, nuts, and pulpy fruits. The larvæ of a few foreign genera, however, (Hypera, Coniatus and Cionus,) live upon the surface of leaves, the pulp of which they devour. These, living exposed to the light, present somewhat variegated colors; and they have two or three simple eyes, or ocelli, on each side of the head. When about to transform, they attach themselves to a leaf or its petiole, and enclose themselves in a thin gauze-like cocoon; a curious anomaly in the Coleopterous order. The larvæ of some of the more minute species belong to the class of leaf-miners, and others inhabit the stems of herbaceous plants, causing them to enlarge into the excrescences known as galls, and which bear a certain resemblance to unripe fruits. As a tribe, therefore, the snout-beetles are pre eminently the occupants and devourers of fruits, and as other tribes of tetramerous beetles are known by the Greek names of Xylophago, or wood-eaters, and Phytophaga, or plant-eaters, the snout-beetles might be properly styled Carpophaga, or fruit-eaters; but we have retained the name by which they are generally known, and which is so happily expressive of their most distinctive character, namely: Rhynchophora, or snout-bearers.

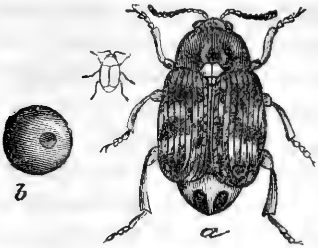
This tribe of beetles comprises the four following families:

A. Labrum and palpi normally developed; antennæ not elbowed; snout short and thick.
  B. Antennæ saw-toothed; eyes notched.............................BRUCHIDÆ.
  B B. Antennæ clavate; eyes round or slightly sinuate............ANTHRIBIDÆ.
A A. Labrum and palpi obsolete.
  C. Antennæ straight and filiform; proboscis pointing directly forwards; body elongated...BRENTHIDÆ.
  C C. Antennæ clavate and usually elbowed; snout various.....CURCULIONIDÆ.

Family LV. BRUCHIDÆ.

This is a small family of small-sized beetles, always less than a quarter, and sometimes one-eighth of an inch in length. The only tetramerous beetles with which they could be confounded are the Curculionidæ and the Chrysomelidæ; but they differ from the former by having the labrum and palpi of the ordinary form, and the head is but little prolonged anteriorly; and they differ from the great majority of the latter in their short, serrate antennæ, and in having the tip of the abdomen uncovered by the elytra. But a few aberrant genera of Chrysomelidæ,

[Fig. 59.]



BRUCHUS PISI, Linn.:—*a*, beetle enlarged, the small outline showing natural size; *b*, a pea from which the beetle has escaped—after Riley.

(*Babia*, *Saxinis* and *Coscinoptera*,) resemble them in these characters, thus showing the close relationship between the two families. The present family contains the well known pea and bean weevils, which are often very seriously injurious to these crops. The pea-bugs make their appearance and deposit their eggs in the early part of the summer, and as they have but one brood in a season, we can obtain sound seed by planting peas as late as the first of June.

The family contains but a few genera, and all our injurious species belong to the genus *Bruchus*, Linn.*

The most notorious species are the pea-weevil (*Bruchus pisi*, Linn.); the bean-weevil (*B. obsoletus*, Say), and the grain-bruchus (*B. granarius*, Linn.) The latter is a European species which has been imported in small numbers into this country.

Family LVI. ANTHRIBIDÆ.

This and the following family are really only sub-divisions of the great Curculio family, from which it is distinguished by the presence of an upper lip and palpi, and the straight antennæ. The larvæ inhabit the seeds and stems of plants, and some have short but well developed feet. The larvæ of the genus *Brachytarsus*, which is composed of very small species, are found under the scales of bark-lice, and are supposed to be parasitic, thus presenting a remarkable anomaly in this tribe of beetles. The species are much more numerous than the Bruchidæ, but none of them have proved injurious to cultivated crops. The name is derived from the Greek *anthos*—*a flower*, and *tribo*—*to destroy*.

The following are the four principal genera:

A. Thorax with a transverse ridge in front of the posterior margin ....TROPIDERES, 2 sp.
A A. Thorax without transverse ridge.
B. Body oblong oval; rostrum with parallel sides.
C. Anterior coxæ rather widely separated; eyes small and finely granulated......ANTHRIBUS, 2.
C C. Anterior coxæ but slightly separated; eyes large and coarsely granulated...CRATOPARIS, 3.
B B. Body short; size small; rostrum cut obliquely..........................BRACHYTARSUS, 5.

*In Mr. Crotch's Check list the generic name *Mylabris*, of Geoffroy, is substituted for *Bruchus*, Linn. The former term, derived from the Greek *mu-le*—*a grain-mill*, was applied by the Greeks to some kind of insect found in mills and baking houses, and supposed by some to have been a species of *Blatta*, or cockroach, and by others, the common meal-worm or larva of the *Tenebrio molitor*; but was applied by Geoffroy to the beetles of the present family. A few years later, Linnæus, having overlooked the name given by Geoffroy, re-described these insects under the name of *Bruchus*, also an ancient Greek name of some kind of insect, supposed to have been a species of locust, but which cannot now be determined with certainty. As these insects feed upon grain and other seeds, the name given by Geoffroy has the claim of appropriateness, as well as of priority, but the term *Bruchus* has become established by universal adoption and long continued usage, so that, like many other words, it may be said to have acquired a meaning of its own, independent of its origin.

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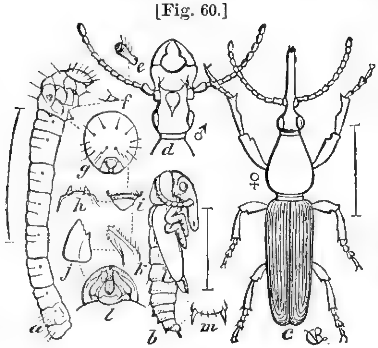
Family LVII. BRENTHIDÆ.

This, like the preceding family, might be regarded, more properly perhaps, as one of the sub-families of the Curculionidæ. It agrees with them in the important characters of the elongated snout, the undeveloped labrum and palpi, and the spongy and usually bilobed tarsi. It differs from the great majority of them in its non-elbowed antennæ, and the uniform absence of the minute terminal joint, which forms a twelfth or supernumerary joint in the antennæ of many of the Curculionidæ; and also in the greatly elongated form of the body, especially in some of the foreign species. The family is considerably numerous, upwards of six hundred species being known to exist in cabinets, most of which are found in tropical regions. Indeed only a single species is known to inhabit the continent of Europe, and but three species are found in North America, north of Mexico, and of these only one inhabits the more northern parts of the United States. This is the species commonly known as the Northern Brenthian, which is figured in all its stages in the accompanying cuts. Much interest has become attached to this species from its being the only one of the Brenthian family whose larval history has been traced, and also from the uncertainty in which this history has been involved. In a Report upon the Insects of Massachusetts, published in 1838, Dr. T. W. Harris gave a history of the habits of this insect, together with a description of certain larvæ found in company with the perfect insects, and communicated to him by the Rev. L. W. Leonard of Dublin, New Hampshire. As these larvæ were likewise accompanied by pupæ having the characteristic snout of the Brenthian, bent down between the forelegs, it seemed to be almost demonstrated that the insect in all its stages was here exhibited. But as these larvæ departed widely from the Curculionide type, in having well developed legs, and an anal proleg, subsequent authors have generally held the opinion that some mistake must have occurred in the matter. These doubts have recently been cleared up in Mr. Riley's Sixth Annual Report upon the Insects of Missouri. It therein appears, from specimens communicated to the author by Mr. Wm. R. Howard, of Forsyth, Missouri, that the larvæ of Brenthus do not differ essentially from other Curculionide larvæ. Mr. Riley concludes that the larvæ sent to Dr. Harris by Mr. Leonard, must have appertained to some one of the Tenebrionidæ; sim-

[Fig. 60.]



EUPSALIS MINUTA:—*a*, larva; *b*, pupa; *c*, female beetle; *d*, head of male do.; *f*—*l*, leg and head parts of larva; *m*, end of body of pupa, dorsal view—after Riley.

ilar larvæ having been found by himself in company with the Brenthians, and which he conjectures to be those of the *Strongylium tenuicolle*, Say.

The Northern Brenthus is frequently found under the bark of different kinds of oak, in an incipient state of decay, but the larvæ are genuine wood-borers penetrating into the heart wood, usually of dead, but sometimes of living trees. The beetles vary from one-third to two-thirds of an inch in length. They are of a mahogony-brown color, with the elytra deeply grooved, and marked with linear spots of a tawny-yellow color. The male and female differ remarkably in the shape of the snout, as shown in the accompanying figures.

The species was first described by Drury from a small specimen, under the name of *Brenthus minutus*, and it is now included in the sub-genus *Eupsalis* of Lacordaire, which the author admits to be scarcely distinct from *Arrhenodes*, Sch. It has usually been referred to under the appropriate name of *Brenthus (Arrhenodes) septentrionis*, (or more properly, *septentrionalis*) of Herbst, which is equivalent to the common name of the Northern Brenthus.

Family LVIII. CURCULIONIDÆ.

This is the extensive family of snout-beetles, properly so called. The statements made in describing the tribe of Rhynchophora, of which they compose by far the larger part, had reference chiefly to the Curculionidæ,* and need not be here repeated. Their bodies are always of an oval form, never being very much elongated or depressed. The snout varies extremely, being sometimes short and broad, and sometimes as long as the body and almost as slender as a hair. Their most important organic character is the negative one of the absence of the labrum and the rudimental condition of the palpi. Like all the plant-eating Tetramera their tarsi are clothed with a dense brush of short stiff hair on the under side, and the last joint but one is strongly bilobed. Another very distinctive character is the bent or elbowed form of the antennæ, which is caused by the first joint being much longer than the others, and forming an angle with them. The antennæ are almost always knobbed at the end. The larvæ are soft and white, slightly narrowed at each extremity, and usually lying in a curved position. They are always destitute of feet, but in their place we often find little elevations or papillæ which are sometimes surmounted by a coronet of fine bristles. They always occupy the substance of plants, and therefore require but little locomotion. Though they are emphatically the occupants of fruits and

* *Curculio* was the ancient name of some kind of corn-worm.

fruit-like galls, yet there is no part of a plant which is not inhabited by the larvæ of some one or other of their numerous species.

The snout-beetles consequently furnish a greater number of species which are injurious to the agriculturist than any other family of beetles. In depositing their eggs the females first puncture a hole with their snouts, then drop an egg at the aperture, and lastly with the aid of the proboscis push the egg to the bottom of the cavity. In harmony with this mode of egg-deposit is the organic character observed in many species, of the female having a proboscis considerably longer than that of the male; of which our Apple-curculio (*Anthonomus 4-gibbus*) furnishes an example.*

The classification of the Curculionidæ, on account of their great numbers and the small size of the great majority of them, taken in connection with the rudimental state of some of the organs, namely, the labrum and the palpi, which, in other insects, often furnish valuable generic characters, presents a difficult study which will tax both the patience and the ingenuity of the student.

They are divided primarily into two large sections, according to the length of the rostrum or snout, and the point of insertion of the antennæ, and designated as the Brevirostres or short-snouted Curculios, and the Longirostres or long-snouted Curculios. These sections not being sharply separated from each other in nature, Lacordaire has adopted, as the basis of the primary division of the Curculionidæ, the relative position of certain parts of the mouth; but these parts are often so minute and obscure that the characters derived from them are very diffi-

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* In a paper on the systematic value of the Rhynchophora, read before the National Academy of Sciences, at Washington, Jan. 24, 1867, Dr. LeConte adduces this habit of the Curculionidæ of pushing their ova into the cavities prepared for them by means of the rostrum or beak, as an evidence of degradation or inferiority of type. "It was reserved," he says, "for the Rhynchophora to exhibit a degradation of type, by which a function, peculiarly appropriate to the posterior extremity of the body, is performed by the head: the elongated beak becoming in fact the ovipositor."

Dr. George H. Horn, in an article upon the Curculionidæ, contributed to the American Philosophical Society, Sept. 19, 1873, in describing the species of the genus Balaninus, states that the females have a slender ovipositor, which they are capable of extending to half the length of their bodies, and that he possesses a specimen with the ovipositor protruded, and an egg seized by its tip. From this he infers that the Balanini, and probably other Curculionidæ also, use their beaks only to make the perforation into which the egg is to be deposited, but that the act of inserting the egg is done in the ordinary way by the ovipositor.

The fact, however, that many, (if not all) of the Longirostres, or long-snouted Curculios, use their beaks to force their ova to the bottom of the cavities prepared for them, is too well attested to admit of question. Several species of Rhynchites and Anthonomus are described as thus ovipositing, in Kollar's Treatise, (page 238, et. seq.); and the common Plum-curculio, (*Conotrachelus nenuphar*), is known to practice the same method. (See Practical Entomologist, vol. 2, page 115.)

But the argument above stated to prove the relative inferiority of the Rhynchophora, appears to me more fanciful than real. The great majority of Coleoptera have neither beak nor ovipositor, and simpl deposit their eggs upon the surface of the substances upon which, or within which, their larvæ are to reside. The additional precautions taken by the Rhynchophora to ensure the preservation of their eggs and the welfare of their offspring, would seem to furnish a more certain proof of superiority of instinct, than of any systematic degradation.

cult of application. We have therefore followed the more popular classification of Latreille and Schœnherr, so far as respects this primary division.

Section 1. *Brevirostres.* Rostrum short and broad, never much longer than the head; scrobes extending to the end of the rostrum, and the antennæ inserted at or near their extremities. Anterior coxæ contiguous. Elytra covering the whole of the abdomen.

Section 2. *Longirostres.* Rostrum usually much longer than the head, narrow and cylindrical; scobes very rarely reaching the end of the rostrum, and the antennæ usually inserted at a greater or less distance from its extremity, generally near the middle, and sometimes at its base. Coxæ and elytra various.

The Longirostres, which are much the most numerous, are divided by Lacordaire, into two sub-sections accordingly as the anterior coxæ touch each other, or stand more or less apart. The former he names *Synmerides*, meaning *thighs contiguous;* and the latter *Apostasimerides*, (which we have contracted to *Apomerides*), meaning *thighs separate.*

The word *scrobe*, used in describing the Curculionidæ, is the name given to the channel on each side of the rostrum for the reception of the antennæ. The term *occular lobes* refers to the form of the anterior and lateral margins of the thorax, which, in this case, curve forwards so as to touch or partly cover the eyes. *Scape* is the same as *pedicel*, and is the name of the elongated first joint of the antennæ. The *rostral canal* is the name of the groove in the prosternum of some species for the reception of the rostrum when it is bent under the breast in repose.

It is necessary to bear in mind that as the Curculionidæ are, for the most part, small insects when compared with the Coleoptera in general, the terms large and small, when applied to particular groups or species, have a modified significance. A curculio half an inch or upwards in length, is comparatively *large;* one a quarter of an inch, is *medium;* and one an eighth of an inch or less, is *small* or *very small.*

The following tables exhibit the principal groups or sub-families into which this extensive family has been divided:

Section 1. *Brevirostres.*

A. Antennæ straight; eyes round.............................ITHYCERIDES.

A A. Antennæ slightly elbowed; eyes oblong, narrowed inferiorly..CLEONIDES.

A A A. Antennæ strongly elbowed.

B. Eyes large, depressed, transverse, pointed at the lower extremity. Prothorax with ocular lobes; scrobes directed inferiorly .... LEPTOPSIDES.

B B. Eyes round or oval.

D. Prothorax without ocular lobes; eyes generally moderate—sometimes round, sometimes oval.

E. Mentum large, concealing the maxillæ; sternum not hollowed in front.
F. Scrobes linear directed beneath the rostrum; scape rarely extending beyond the posterior border of the eyes, often not reaching it: BRACHYDERIDES.
F F. Scrobes often dilated, forming winglets (*pterygia*) on the sides of the end of the rostrum, never linear and directed beneath; scape extending beyond the eyes (except in Brachystylus,): OTIORHYNCHIDES.
E E. Mentum small, not concealing the maxillæ; sternum more or less hollowed out in front to receive the rostrum.
G. Scrobes deep, linear, reaching the mouth.
H. Scrobes reaching the eyes. Rather large insects, either glabrous or pubescent.............................. ....MOLYTIDES.
H H. Scrobes various in length; small insects clothed with hairs or fine scales...............................HYPERIDES.
G G. Scrobes short, curved, sub-basal..................ATERPIDES.
D D. Prothorax with ocular lobes; eyes generally large, oval and transversal.
I. Tarsi hispid, not spongy beneath; third joint not dilated nor bilobed...............................BYRSOPSIDES.
I I. Tarsi spongy; third joint bilobed.
K. Rostrum widened and hollowed triangularly at the end; scrobes confluent on the under side of rostrum: PROMECOPIDES.
K K. Rostrum more or less enlarged, but not notched at the end; scrobes shallow and incomplete posteriorly: CYLINDRORHINIDES.

Section 2. *Longirostres.*

First Sub-section—*Synmerides.* Anterior coxæ nearly or quite contiguous; never with a groove between them for the reception of the rostrum.

A. Antennæ elbowed, first joint much longer than the others.
B. Body oblong, cylindrical, covered with a fine powder; tarsal claws soldered together at base...LIXIDES.
B B. Body not cylindrical and pulverulent; ungues free.
C. All the tibiæ terminated with a claw.
D. Thorax longer than wide, swollen anteriorly; narrowed behind; eyes round...OTIDOCEPHALIDES.
D D. Thorax narrowest in front; eyes oval or oblong.
E. Body rough; eyes almost or quite contiguous above; abdominal sutures very deep ..................................PRIONOMERIDES.
E E. Body smooth, glabrous or pubescent.
F. Body elongate, sides parallel, glabrous, punctured; usually black or blueish ....MAGDALINIDES.
F F. Body oval; usually brownish and pubescent, and often variegated.
G. Tibiæ slightly compressed and hollowed on the inner side; rather large insects; inhabit pine trees...................HYLOBIIDES.
G G. Tibiæ round; small insects; usually found on low plants: ERIRHINIDES
C C. Tibiæ unarmed or simply mucronate at the end.

H. Rostrum very long and slender; prosternum well advanced in front . . . . BALANINIDES.

H H. Rostrum not excessively long; prosternum very short in front of anterior coxæ.

I. Eyes rather small, round; hind thighs not thickened: ANTHONOMIDES.

I I. Eyes contiguous above; hind thighs enlarged for jumping: ORCHESTIDES.

A A. Antennæ straight, first joint not much longer than the following ones; anterior coxæ elongated.

K. Rostrum short or moderate, more or less widened at the end; tip of abdomen exposed . . . . ATTELABIDES.

K K. Rostrum long and slender; abdomen wholly covered by elytra; body pear-shaped . . . . APIONIDES.

Second Sub-section—*Apomerides*. Anterior coxæ more or less distant from each other, and frequently with a groove, or rostral canal in the prosternum, between them.

A. Capitulum of antennæ ordinary, with transverse incisions; tarsi spongy beneath; third joint bilobed.

B. Anterior coxæ exceptional, being nearly or quite contiguous; rostral canal very short, but distinct; thighs often with a tooth . . . . . CONOTRACHELIDES.

B B. Anterior coxæ separate.

C. Antennæ elbowed.

D. Hind margin of the abdominal segments straight.

E. Rostral canal wanting; anterior coxæ large, sub-globular and wide apart; tip of abdomen largely exposed . . . . LEMOSACIDES.

E E. Rostral canal distinct; anterior coxæ ordinary; tip of abdomen little or not exposed.

F. Rostrum thickened at the end (ex. Analcis); abdomen ordinary; eyes large, oval, not contiguous above . . . . CRYPTORHYNCHIDES.

F F. Rostrum slender; venter turned up behind; eyes contiguous: ZYGOPIDES.

D D. Hind margin of second and sometimes third and fourth abdominal segments arched or angulated.

G. Rostral canal short or wanting; scutellum indistinct or wanting; colors various . . . . CEUTORHYNCHIDES.

G G. Rostrum often thickened and compressed at base; rostral canal wanting; scutel distinct; color black or bronze . . BARIDIIDES.

C C. Antennæ straight, very short; first joint short and obconic; rostrum short.

H. Eyes on the front, sub-contiguous; hind legs very long; hind coxæ very wide apart . . . . TACHYGONIDES.

H H. Eyes lateral; legs ordinary; tip of abdomen largely exposed: PTEROCOLIDES.

A A. Capitulum solid, globrous, with a spongy tip; tarsi entire, not, or but slightly, spongy beneath.

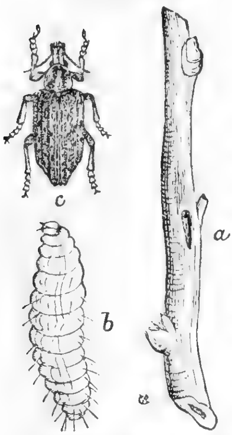
I. Eyes large; tip of abdomen exposed; size medium or large: CALANDRIDES.

I I. Eyes small or wanting; abdomen wholly covered by elytra; small, black or brown, usually glabrous . . . . . . COSSONIDES.

We will add a few additional notes upon those sub-families which are most common or most numerous in species, and which will therefore be most likely to occur to the student:

Section 1st. *Brevirostres.*

[Fig. 61.]



ITHYCERUS NOVEBORACENSIS, Forster:—*a*, slit made in oak twig by female for depositing her eggs; *b*, larvæ; *c*, beetle—after Riley.

Sub-family ITHYCERIDES.

This sub-family has been formed to receive a single N. American species, the *Ithycerus noveboracensis*, or New York weevil, a comparatively large and rather common species which is sometimes considerably injurious to apple trees by devouring the buds and bark of young twigs. It differs from all other short-snouted weevils in not having the antennæ elbowed. The rostrum is robust, and the scrobes very short and oblique. It is a bulky insect five or six-tenths of an inch long, of a gray color, with a few small black spots on the wing-covers. The name is derived from the Greek *ιθυς* straight, and *κερας* antennæ.

Sub-family CLEONIDES.

In these the antennæ are but slightly elbowed, thus forming a transitional group from the Ithycerides to those which follow. The rostrum is rather robust and angular or carinated above, and longer than the head; the scrobes are linear and deep, directed beneath, but not meeting behind. The thorax is almost always furnished with ocular lobes. The tibiæ terminate in a dagger-like spine. These are large species averaging about half an inch in length; oblong, cylindrical and pubescent. The larvæ of some are found in the stems of thistles. Six N. A. species have been described, all belonging to the genus *Cleonus* of Megerle.

Sub-family LEPTOPSIDES.

The most striking character of this group is the form of the eyes, which are large and placed transversly or crosswise of the head, and more or less narrowed and pointed at their lower extremity, whence, in common with some others, they have been denominated by Lacordaire *Oxyopthalmes*, meaning *pointed eyes*. We have two N. A. genera, *Panscopus*, Sch., and *Ophryastes*, Sch.; the former contains but one species, the *P. erinaceus*, Say, a sordid brown curculio, a little more than quar-

ter of an inch in length, with a rough surface and clothed with short stiff hairs. We have taken them abundantly in Michigan, under the chips placed as traps for the Plum-curculio. Thirteen species of Ophryastes have been described, none of which have been found east of the Mississippi river. They are large species covered with cinereous scales. The eyes are partly covered by the prominent ocular lobes. The family name is derived from Leptops, (meaning *narrow eyed*) a genus peculiar to Australia.

Sub-family BRACHYDERIDES.

This sub-family comprises an extensive and considerably heterogeneous assemblage of insects, which, taken in connection with the Otiorhynchides which follow, constitute the greater part of the division called, by Lacordaire, *Cyclopthalmes*, meaning *round eyes*, and which are distinguished by the union of the three characters of short snouts, round eyes and the maxillæ covered by the mentum. The Brachyderides are for the most part comparatively large species, often clothed with fine scales; most of them are found upon the ground, but some upon herbaceous plants. The sub-family contains the following N. A. genera, with the number of described species in each: Epicærus 7, Pandeleteius 1, Polydrosus 2, Sitones 8, Tanymecus 5, Thalacites 1, Pachnæus 2, Parynotus 1, Lachnopus 1, Platyomus 1, Strophosomus 1.

Sub-family OTIORHYNCHIDES.

This word literally means *ear-snouted*, and is intended to express the most peculiar character of the sub-family, which consists in an ear-like expansion on each side of the end of the rostrum, but some species are included which have not this character. Another distinctive character is the length of the scape, or first joint of the antennæ, which, except in the genus Brachystylus, always extends backwards beyond the eyes. Many species are found under moss and grass. Such larvæ as are known feed upon the roots of plants. N. A. genera: Otiorhynchus 3 species, Agraphus 1, Tyloderes 1.

Sub-family CYLINDRORHINIDES.

Rostrum as long, at least, as the head, rather stout, and more or less enlarged at the end. Scape reaching the eyes. Eyes oblong and transversal. Thorax with ocular lobes, and imperfectly contiguous to the elytra. This sub-family contains the genus *Listroderes*, Sch., of which seventeen N. A. species have been described. This genus forms one of the transitional groups between the short-snouted and the long-snouted Curculionidæ, the rostrum being usually nearly twice as long

as the head. They can be distinguished from most allied groups by the eyes being partly covered by the ocular lobes, a character possessed by very few N. A. Curculionidæ. The species vary from an eighth to a half of an inch in length.

Section 2d. *Longirostres.*

Sub-family LIXIDES.

With this sub-family commences the section of Longirostres, the snout being cylindrical and decidedly narrower and longer than the head, but their transitional position is shown by the antennæ being inserted not very far from the end of the rostrum. The Lixides are distinguished by their elongate, almost cylindrical bodies, which are covered with a fine dust, like the bloom on a fresh plum or grape. This bloom is sometimes bluish, sometimes orange, and is very easily rubbed off, so that perfect specimens are rarely obtained; and for this reason it is often difficult to identify the species. They are of rather large size for this family, the species usually ranging from a third to half an inch in length. Some of them inhabit water plants, and some foreign species breed in the stems of thistles.

We have two genera: *Lixus*, Fab., 13 species; and *Larinus*, Germar, 2 sp. In the latter genus the scrobes, or grooves on the side of the rostrum, usually meet behind on the under side.

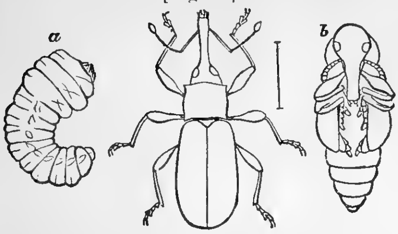
Sub-family OTIDOCEPHALIDES.

This name is derived from the Greek *otis*, a kind of *owl*, and *kephale*, the *head*; the swollen anterior part of these insects having some fancied resemblance to the head of an owl. The thorax is swollen before and narrowed behind, a character not found, we believe, in any other Curculionidæ, and which has caused them to be compared with ants. The antennæ are inserted rather near the end of the rostrum. The sternum is concave or hollowed in front.

The sub-family is composed of the single genus *Otidocephalus*, Chevrolat. The species are from an eighth to a quarter of an inch in length, and usually of a shining black color. They are exclusively American. Five species have been described which inhabit the United States.

Sub-family MAGDALINIDES.

[Fig. 62.]

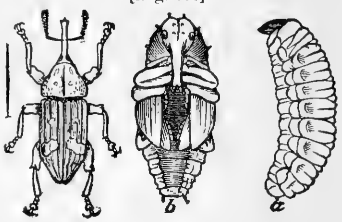


MAGDALINUS OLYNA:—*a*, larva; *b*, pupa—after Packard.

Rostrum rather long and cylindrical; scobes linear, commencing near the middle, and reaching the base. Eyes transverse, approximate above. Prosternum not excavated. Small species of an oblong parallel form, glabrous, usually black or blue, but sometimes reddish. Thorax deeply punctate. Elytra punctate and striate. The larvæ depredate upon the pine, boring into the pith of the smaller branches. A foreign species is said to have been reared from a larva found in burrows under the bark of willow trees. The *M. armicollis*, Say, inhabits the elm. Nearly all the species belong to the typical genus *Magdalis*, Germar, of which seven N. A. species have been described.

Sub-family HYLOBIIDES.

[Fig. 63.]



PISSODES STROBI:—*a*, larva; *b*, pupa—after Packard.

Rostrum twice as long as the head, cylindrical, sometimes moderately robust; scrobes deep, linear and oblique. Scape clavate, nearly or quite reaching the eyes.

The anterior coxæ are somewhat separated. The tibiæ usually compressed, often curved, and terminated by a stout curved spine. Tarsal claws elongated. Size rather large. Body oblong and pubescent. The larvæ gnaw galaries under the bark of trees, chiefly the pines, often doing much injury. This habit is expressed by the family name, which means, *living in wood.*

The sub-family contains the following N. A. genera: *Hylobius*, Germar, 3 species. *Eudocimus*, Sch., 1. *Pissodes*, Germ., 5. *Heilipus*, Germ., 3. *Lepyrus*, Germ., 3.

Sub-family ERIRHINIDES.

From the Greek ριν, ρινος, the *nose* or *snout*, with the intensifying prefix ερι. Rostrum long and slender. Scrobes commencing at a distance from the mouth and reaching the eyes. Antennæ long and slender. Scape sub-clavate. Tibiæ slender, not compressed, and usually with a spine or claw at the end. These are distinguished from the Hylobiides chiefly by the form of the tibiæ; but they embrace a number of groups, each of which has some remarkable peculiarity.

In the group Cryptoplides, containing the genera *Endalus*, *Brachybamus*, and *Smicronyx*, the fourth joint of the tarsi scarcely extends beyond the lobes of the third. In the group Hydronomides, represented in this country by the genus *Bagous*, Sch., the tarsi differ from the common type of the Curculionidæ in being slender, and not spongy beneath, and the third joint not bilobed; the fourth joint is elongated. The species of this group are found on aquatic plants, and their bodies are covered with minute scales which shed the water.

The species of this sub-family are all small, ranging from a quarter to a tenth of an inch in length. The described N. A. species are as follows: *Erirhinus*, Sch., 10 species. *Endalus*, DeCasteln, 4. *Brachybamus*, Sch., 2. *Bagous*, Sch., 2.

Sub-family BALANINIDES.

[Fig. 64.]

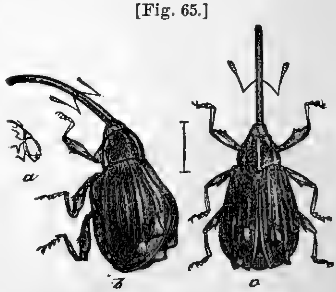
Balaninus—after Rye.

From *Βαλανος*, a *nut* or *acorn*, in which the larvæ reside. Head globular. Rostrum very long, slender and filiform. Scrobes linear, commencing a little beyond the middle of rostrum and reaching the base. Antennæ slender. Eyes large. End of abdomen slightly exposed. Distinguished at once by their long, slender rostrum, almost as fine and glossy as a hair. The larvæ inhabit nuts and fruit, and sometimes the galls made by other insects. The female pierces a hole with her rostrum for the deposition of her eggs. They enter the ground to transform. The species are, for the most part, of medium size, and of a mottled brownish color. The sub family is composed of the genus *Balaninus*, Germar, of which 8 N. A. species have been described.

Sub-family ANTHONOMIDES.

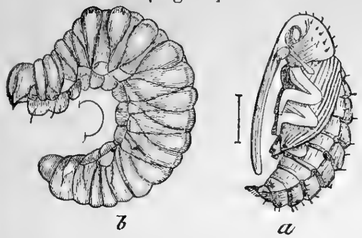
Head somewhat conical. Rostrum slender and projecting forwards, and varying in length in different species, and sometimes in the two sexes of the same. Scrobes linear, commencing near the middle of the rostrum and reaching the base. Eyes approximate above. End of abdomen little or not at all exposed. These are small, somewhat pear-shaped curculio, without any very strongly marked characters. They are a very important sub-family, in an economic point of view, many of them

[Fig. 65.]



Anthonomus, 4-gibbus, Say:—Apple Curculio; *a*, natural size; *b*, *c*, side and back view, enlarged—after Riley.

[Fig. 66.]



ANTHONOMUS, 4-GIBBUS, Say:—*a*, pupa; *b*, larva, enlarged—after Riley.

being injurious to fruits. Kollar has described the habits of two European species, the Apple-weevil, *A. pomorum*, Fab., and the Pear-weevil, *A. pyri*, Kollar, which deposit their eggs in the fruit buds of these trees. The Apple curculio, *A. quadrigibbus*, of Say, (Fig. 65) and the Plum-gouger, *A. prunicida*, of Walsh, are well known American species. Both of these deposit their eggs in the fruit. The larvæ of these insects do not go into the ground to pupate, like the common Plum-curculio and many others, but go through all their stages in the buds or the fruit which they infest. All the N. A. insects of this sub-family belong to the genus *Anthonomus*, Germ., of which 15 species have been described.

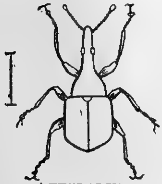
Sub-family ORCHESTIDES.

From *ορχηστης*, a *dancer* or *jumper*. These resemble the Anthonomides in most of their characters, but differ in having the hind thighs much swollen, with a corresponding muscular development which gives to them the power of jumping. The prosternum is very short, permitting the rostrum to be bent beneath in repose. Eyes large, oval, and nearly meeting above. This little group is very remarkable for the structure and habits of the larvæ. They are somewhat flattened, and pointed behind, and furnished with six feet, a remarkable departure from the apodal character of other curculionide larvæ. But the most anomalous circumstance is that these larvæ are leaf-miners, a habit of which there are but few examples* in the order of Coleoptera, and exhibiting a curious analogy to the larvæ of many of the Micro-Lepidoptera; and this analogy is carried out by the larvæ when fully grown and about to change to pupæ, enclosing themselves in silken cocoons. Two N. A. species have been described by Mr. Say belonging to the genus *Orchestes*, Illiger. They are only about a tenth of an inch in length.

Sub-family ATTELABIDES.

Rostrum more or less robust and enlarged at the extremity; scrobes superior, large and pit-shaped. Antennæ straight, or not elbowed, the first joint being but little longer than the following ones. This character readily distinguishes this and the following sub family from the great majority of Curculionidæ. They are divided into two groups: the Attelabides proper, with short, thick bodies, tibiæ unguiculate at the end, and claws soldered together; and

[Fig. 67.]



ATTELABUS.

* Other examples are found in Hispa and Haltica.

the Rhynchitides, more elongate and depressed, with unarmed tibiæ, and free, usually bifid claws.

The females roll up leaves and deposit their eggs singly in the cavities thus made. The larva inhabits this cavity, and, when fully grown, leaves it and goes into the ground to transform. N. A. genera: *Attelabus*, Linn., 5 species; *Rhynchites*, Herbst, 8; *Eugnamptus*, Sch., 2.

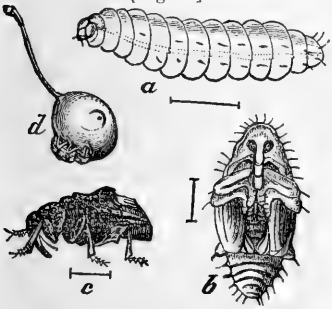
Sub-family APIONIDES.

From *απιον*, a *pear*. Rostrum long, curved, cylindric or subulate; scrobes foreiform or pit-shaped. Antennæ not elbowed. Size small or very small; body pear-shaped, usually glabrous, and without wings. Habits of the larvæ various. Some live in seeds, especially those of the leguminosæ. Some form galls on the stems and leaves of plants. Some bore into the pith of certain plants and form a kind of cocoon of the detritus or gnawed particles. Finally, some inhabit knots which they form upon the roots of plants. Twenty-one N. A. species of the genus *Apion*, Herbst, have been described.

Sub-family CONOTRACHELIDES.

Meaning having a *conical thorax*. With this sub-family we pass to the sub-section of Apomerides (Apostasimerides, Lacordaire,) a term derived from the Greek *apo—apart*, and *meros*—the *thigh*, in allusion to the greater or less separation from each other of the anterior coxæ; whereas in all the preceding sub-families these parts stand nearly or quite in contact. The present is a transitional group in this respect, the anterior coxæ being but slightly separated. The rostrum is various as to length; the scrobes turn rapidly beneath, and are confluent behind, being imperfectly visible on the sides. The ocular lobes are advanced so as to nearly or quite cover the eyes when the rostrum is bent down. Thighs usually with a tooth on the under side. Size small, or medium; colors generally obscure. The sub-family is exclusively American. Fourteen N. A. species have been described. The notorious Plum-curculio, *Conotrachelus nonuphar*, Herbst (Fig. 68), may be taken as an example of the genus and its larvæ.

[Fig. 68.]



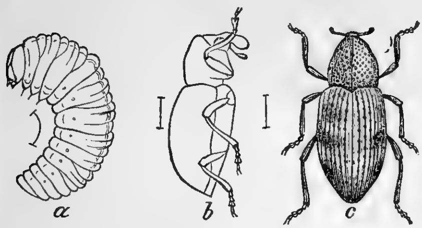
CONOTRACHELUS NENUPHAR, Herbst:—Plum and peach curculio—*a*, larva; *b*, pupa; *c*, beetle; *d*, a plum, showing the crescent slit made by the female after depositing her egg—after Riley.

Sub-family CRYPTORHYNCHIDES.

Rostrum varying in length, usually somewhat enlarged both at base and tip (attenuated in Analcis.) Scrobes oblique. Antennæ far from

base of rostrum; scope at most reaching the eyes. Rostral canal extending onto the mesosternum. Eyes large, pointed inferiorly. Ocular lobes more or less prominent. Thighs sometimes toothed beneath. Tibiæ spined at the end. In Cryptorhynchus proper the tibiæ have a band of rigid hairs near the extremity, usually bright yellow, but sometimes black. These are small species found on plants. The body is of various form, and is usually clothed with scales. The family name signifies having a *concealed snout*, and has reference to the rostrum being bent under the breast, and lying in the groove called the rostral canal. N.A. species: *Cryptorhynchus*, Illiger, 11; *Acalles*, Sch., 3; *Pseudomus*, Sch., 1; *Analcis*, Sch., 4.

[Fig. 69.]



ANALCIS FRAGARIÆ, Riley:—Strawberry crown-borer—*a*, larva; *b*, outline side view; *c*, back view of beetle—after Riley.

Sub-family CEUTORHYNCHIDES.

Rostrum cylindric, not thickened at base; scrobes lying along the inferior edge of the rostrum, rarely very oblique. The rostral canal varies in the different groups, as shown below. Scutellum wanting or indistinct. The three intermediate segments of the abdomen strongly arched. Tibiæ unarmed. The name means the same as that of the preceding sub-family, and implies that the rostrum is more or less concealed, but the prosternal groove is here usually less distinct, and sometimes wanting. They are chiefly distinguished from the Cryptorhynchides by the absence of scutellum, and of points at the end of the tibia, and by the abdominal segments strongly arched behind. They are small insects, found mostly on low herbage in wet places. The habits of the larvæ are various, some inhabiting seeds, and others the stems or roots of plants. The Mononychi transform on the plant, whilst the Ceutorynchi go into the ground and enclose themselves in cocoons. The species are numerous, and are divided by Lacordaire into three groups, as follows:

A. Eyes covered, at least partly, by the thorax.
  B. Rostral canal extending onto the mesosternum, and sometimes the metasternum...CŒLIODIDES.
  B B. Rostral canal not extending beyond the anterior coxæ..............CEUTORHYNCHIDES proper.
A A. Eyes exposed. Rostral canal indistinct or wanting..............................PHYTOBIIDES.

In the first group we have one species of the genus *Mononychus*, Germar, the *M. vulpeculus*, Fab., found on the flowers of the wild Iris, and five species of *Cœliodes*, Sch. In the second group, *Ceutorhynchus*, Germar, 5 species. In the third group, *Phytobius*, Sch., 3 species; *Cœlogaster*, Sch., 1 species; and *Rhinoncus*, Sch., 1 species.

Sub-family BARIDIIDES.

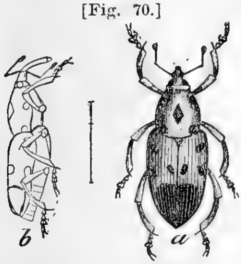
Rostrum various, often compressed and thickened at base; scrobes commencing near the middle, and turning rapidly beneath. Scutellum distinct. Rostral canal wanting; but in *Centrinus* there is an excavation between the coxæ, which, in the male, often has a spine on each side. Intermediate segments of the abdomen usually arched or angulated behind. The eyes are finely granulated, and partly covered by the thorax. The tibæ are usually mucronate or pointed at the extremity. Size medium or small; of elliptical or rhomboidal form; usually black or brown, sometimes with reddish spots. The larvæ live in the stems or roots of plants, and are sometimes very injurious to cultivated crops. They undergo their transformations in the detritus which they have made, and with which they construct a kind of cocoon.

N. A. genera: *Centrinus*, Sch., (body short and rhomboidal), 11 species; *Baridius*, Sch., (body oblong or oval), 30 species; *Madarus*, Sch., (body oblong rhomboidal), 2 species.

Sub-family CALANDRIDES.

Rostrum more or less elongated; scrobes short. Antennæ basal; scape usually reaching far onto the thorax; knob without joints, horny and shining at base, with a spongy extremity. Eyes finely granulated, large, depressed and approximate below. Tip of abdomen exposed. Tarsi not spongy beneath, 3d joint not bilobed. Size sometimes small, but usually medium or large; some tropical species very large. Color black or reddish. The larvæ of the larger species inhabit the stems of plants, whilst the smaller are usually destructive to grain and seeds. When about to transform they construct a coarse kind of cocoon from the materials in which they live.

[Fig. 70.]



SPHENOPHORUS 13-PUNCTATUS, Illiger:—*a*, variety *pulchellus*, Sch., in which the two spots at the end of each elytron are enlarged and coalesce so as to cover the whole tip; *b*, side view—after Riley.

We have three genera: *Rhyncophorus*, Herbst, of large size, and distinguished for the excessive development of the side pieces of the metasternum, 2 species; *Sphenophorus*, Sch., of medium or rather large size, usually between a quarter and a half of an inch in length, 42 species; and *Calandra*, Clairville, (*Sitophilus*, Sch.,) less than a quarter of an inch in length, 3 species.

Sub-family COSSONIDES.

Rostrum usually rather long; scrobes short, commencing at or beyond the middle. Antennæ short. Eyes small or wanting. Tip of abdomen not exposed. Tarsi short, filiform, not spongy beneath, 3d joint rarely bi-

lobed. Small insects, of an oblong linear form, with puncto-striate elytra, and usually of a shining black or brown color. They form a connecting link between the Curculionidæ and the Scolytidæ, being mostly sub-cortical and lignivorous in their habits. The five following genera are represented in the N. A. fauna: *Cossonus*, Clair., 6 species; *Rhyncolus*, Creutz, 7 species; *Dryopthorus*, Schupp, 1 species; *Lymantis*, Gyll., 1 species, and *Phlœophagus*, Sch., 1 species.

Tribe XVII.

SHORT-HORNED WOOD-BORERS.

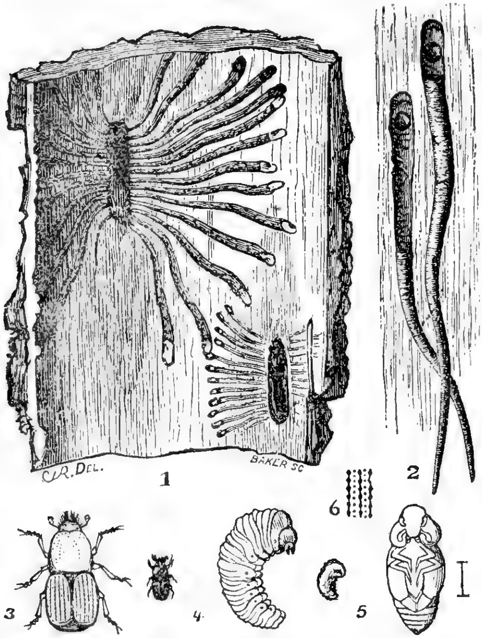
Lignivora brevicornia. XYLOPHAGA, Latreille.

This tribe is composed of small beetles of a short and nearly cylindrical form, and of a brown or blackish color. The antennæ are very short, often not much longer than the head, slightly elbowed, and always terminating in a knob. In many species the abdomen is truncated, or cut off obliquely behind, and terminated with a coronet of short spines. The larvæ are scarcely distinguishable from those of the Curculionidæ, being soft, white, footless grubs, usually lying in a curved position. They differ, however, from the great majority of the larvæ of the Curculios in their wood-boring habits. Indeed, they are pre-eminently the *wood-borers* of the whole order of Coleoptera, no other tribe vying with them in this respect except the Long-horned borers, to be hereafter described. Though small in size, rarely exceeding a quarter of an inch in length, and often less than half that length, they are tolerably numerous in species, and often excessively abundant in individuals. They inhabit various kinds of trees, but mostly the pines, which they have been known to damage considerably in this country, whilst in some parts of Europe they have destroyed whole forests by their enormous multiplication. They are comprised in the single family of Scolytidæ.

Family LIX. SCOLYTIDÆ.

Named from the genus *Scolytus*, Geoff., derived from the Greek *skolupto*—to *denude* or *lacerate*.

[Fig. 71.]



SCOLYTUS 4-SPINOSUS, Say; S. CARYÆ, Riley:—1, shows the burrows of the larvæ between the bark and the wood, growing wider as they diverge from the line where the eggs are deposited; 2, another view of the same, showing the hole made by the exit of the beetle; 3, beetle, both magnified and natural size; 4, larva, the same; 5, pupa magnified—after Riley.

This family is co-extensive with the tribe of short-horned borers which we have just described. They are usually regarded as closely allied to the Curculionidæ; but, as we have stated above, they differ greatly from the latter in their food-habits, and also in the details of their organization. In addition to the characters given above, we may add that they differ from the great majority of the tetramerous beetles, including the Curculionidæ, in having simple tarsi, not spongy beneath, and with the last joint but one not at all, or but very slightly, bilobed. In Dr. Le-Conte's sketch of this family in the 2d Vol. of Trans. of Am. Ent. Society, one hundred and three N. A. species are enumerated, distributed in eighteen genera or sub-genera. But all the more common species may be included in the six following genera:

A. Head free; 1st joint of the tarsi as long as the others united....PLATYPUS.
A A. Head deeply inserted in thorax; first joint of tarsi much shorter than the others united.
  B. Abdomen of the usual form.
    C. Head not globular, visible from above; 3d joint of the tarsi slightly bilobed.
      D. Knob of the antennæ sub-globular.
        E. Six joints in the antennæ before the knob....HYLURGUS.
        E E. Seven joints in the antennæ before the knob....HYLASTES.
      D D. Knob of the antennæ as long as the preceding joints united....HYLESINUS.
    C C. Head globular, invisible from above; 3d joint of tarsi not bilobed....TOMICUS.
  B B. Venter turned up behind....SCOLYTUS.

The *Platypus compositus*, Say, may be taken as a type of this genus in this country. It is one-fifth of an inch long, of a reddish-brown color, and each elytron has a three-toothed elongation at its extremity. Dr. Chapuis, in his monograph of this genus, describes nine N. American species, none of which are very common.

Hylurgus, Latreille, contains a number of well known species, the largest and most common of which is the *H. terebrans*, Oliv., of a reddish-brown color, with the thorax deeply punctured, and quarter of an inch in length. This insect is often seriously injurious to pine trees. An

account of its habits is given in Dr. Harris' Treatise. A much smaller species, the *H. dentatus*, Say, often bores innumerables holes in the red cedar.

We have ten described species of *Hylesinus*, Fab. Whilst the species of Hylurgus and Tomicus are found in evergreens, and especially in the different kinds of pine, the species of Hylesinus and Scolytus inhabit mostly, if not exclusively, the hard-wooded deciduous trees. The most common species is the *H. aculeatus*, Say. The specific name means *prickly*, and has reference to minute elevated points on the elytra. It is a tenth of an inch in length, or a little more, of a blackish-brown ground color, but largely varied with ash color, produced by microscopically minute scales. The top of the thorax is bare, leaving a large elliptical blackish spot. The antennæ are reddish. This little insect is often seen in the first warm days of spring sunning itself upon stumps or fences which run through timbered land. I have found it abundantly in wood which appeared to be that of some species of poplar.

In *Tomicus*, Latr., the tip of the abdomen is cut off obliquely and surrounded with a number of short spines. They are all of a reddish or chestnut color. Three of the species are frequently met with in pine forests, all of which were originally described and named by Mr. Say. They are the *T. exesus*, upwards of two-tenths of an inch in length, with six or eight points at the tip of each elytron; the *T. pini*, three-twentieths of an inch long, the tip of each elytron about four-toothed; and the *T. xylographus*, but little more than a tenth of an inch long, the elytra but slightly truncated, puncto-striate, with minute points on the posterior declivity, between the punctures.

Scolytus, Geoffroy, is distinguished by the singular formation of the abdomen, which is abruptly turned upwards on the under or ventral side, beyond the first segment. The head is usually flattened, and either striated or roughly punctured on top, and surrounded with a coronet of incurved hairs. They inhabit, as we have above stated, the hard-wooded trees. European species live in the oak, the elm, the ash, and the plum. The different kinds of hickory, including the shell-bark, the bitter-nut, and the pecan, are extensively damaged by the *Scolytus 4-spinosus*, Say, so-called on account of four short spines at the tip of the abdomen of the males. The turned up portion of the venter is moreover deeply concave in this sex, and divided down the middle by a carina, or ridge. It is nearly two-tenths of an inch in length, sometimes wholly black, but the elytra are often reddish-brown. The females are about a quarter part smaller, and the venter is but slightly concave, and without either spines or carina. In many groves of timber in Northern Illinois, the bitter-nut hickories have been completely destroyed by the larvæ of these little beetles. They work between the bark and the wood, cutting divergent furrows, as shown in the accompanying figure, and finally

emerging, in the beetle-form, through round holes about large enough to admit a common knitting needle, and giving the tree the appearance, as Mr. Riley aptly remarks, of having been peppered with fine shot.*

Tribe XVIII.

LONG-HORNED WOOD-BORERS.

Lignivora longicornia. EUCERATA, Westwood.

This large and conspicuous tribe of beetles is usually designated by the Latin word Longicornes, meaning *long horns*, in reference to their most striking character, namely, the great length of their antennæ, which, with a very few exceptions, are considerably longer than the head and thorax combined, and frequently longer than the whole body. They are sometimes strictly filiform, but usually setaceous, or tapering. Notwithstanding their great length, they very rarely have more than the normal number of joints, which, in the Coleopterous order of insects, is eleven. The genus Prionus, however, furnishes a remarkable exception in this respect, some of the species having as many as thirty joints in their antennæ. The tarsi are always four jointed, spongy beneath, and the third joint strongly bilobed, characters which readily distinguish them from the predaceous ground-beetles which also have the antennæ slender and considerably elongated.

A few of them have the wing-cases either much shorter, or much narrower than the abdomen, but in these instances, the wings are not folded up under them, as in the short-winged Staphylinidæ, but lie extended and exposed upon the abdomen. They are strong flyers, but do not readily take to flight, and are, therefore, easily captured, though they run with considerable rapidity, their legs being in harmony with the general elongation of their bodies and their antennæ. The thighs are very commonly clavate or enlarged at the end, giving room for an unusual development of the muscles of locomotion.

Many of these beetles, when captured, make a squeaking sound, called *stridulation*, by rapidly moving the prothorax upon the mesothorax. This faculty seems to be possessed by all of the sub-family of Lamiides, and by many of the Cerambycides, but to be absent in the Prionides.

Many of these insects are known to be nocturnal in their habits, and are sometimes seen flying about our lamps in the evening; but others,

* This insect has been described by Mr. Riley under the specific name *caryæ*; but I can find no sufficient grounds for regarding it as distinct from the 4-*spinosus*, of Say. The only positive difference stated is the absence of denticulations at the tip of the elytra, and these, though very minute, are distinct in the specimens which I have examined, of both sexes. The absence of certain details in Mr. Say's description can scarcely be adduced in proof of difference of species, since it was evidently Mr. Say's rule to practice the greatest brevity in his descriptions, consistent with what he deemed a sufficient identification of the species.

especially the Lepturides, are found upon flowers in the day time, and in the full light of the sun.

The larvæ are oblong, straight, moderately firm, sordid or yellowish-white grubs, chiefly distinguished by the depth of the incisions between the segments of the body, giving to them a strongly crenulated or wrinkled appearance. They are usually a little tapering from before backward, the first or prothoracic segment being larger than the others, but never excessively developed as in some of the wood-boring larvæ of the Buprestidæ.

The head is small and more or less sunken in the prothorax, but the larvæ of the Lepturides are exceptional in this respect, their heads being large and flattened and as broad as the pro-thorax.

The majority have six very small feet, which, in some, are scarcely more than rudimental, and the larvæ of the sub-family of Lamiides are distinguished from nearly all the others by being wholly footless—the place of feet being supplied by little callosities.

These larvæ, together with those of the short-horned tribe last described, constitute pre-eminently the wood-borers of the Coleopterous order. Though vastly surpassing the former in size and in the number of species, they would seem to be much inferior to them in the number of individuals, and, therefore, though a few of them have been very injurious to cultivated or ornamental trees, they have never been known to produce such extensive destruction of timber as has been effected by the larvæ of the diminutive but prolific Scolytidæ. A remarkable exception, however, to this statement occurred a number of years ago, in the almost total destruction of the locust tree *(Robinia pseudacacia)* throughout all the Northern States, by the larvæ of the Locust-borer, *Clytus robiniæ*, of Forster. This destruction did not occur in all places at the same time, but was extended mostly over the ten years between 1855 and 1865.

Upwards of 8000 species of longicorn beetles are known to exist in European cabinets. The Smithsonian catalogue of the year 1853 contains the names of 431 N. American species. In Dr. LeConte's New Species of N. A. Coleoptera, published in 1873, eighty-nine additional species are described, and in the intervening twenty years a considerable number of N. A. species had been described by Dr. LeConte and others, both in this country and in Europe.

Some of the characters in the following tables may require explanation. It will be seen that some of the largest Lamiides are distinguished by a cicatrix or scar at the end of the first joint of the antennæ. In these species the pedicel, or stout basal joint, appears as if cut off obliquely at the end, and this sloping part is enclosed by a little ridge or carina, and its surface differs from that of the surrounding parts by be-

ing covered with little elevated points or granulations. This is the part to which the term cicatrix is applied. Another character, valuable for its permanency, is the openness, or the closure, of the middle cotyloid cavity. The cotyloid cavity is the hollow in which the coxa is situated.

In some of the longicornes the posterior angle of the mesosternum is prolonged backwards till it nearly touches the anterior angle of the metasternum, and thus closes the cotyloid cavity on its outer side. In this case the epimeron of the mesothorax is usually narrow, and does not reach the cotyloid cavity. In others, the posterior angle of the mesosternum is but slightly prolonged backwards, leaving the cotyloid cavity open on the outer side. In this case the epimeron of the meso-thorax is larger and extends inwards, so that its inner extremity, which is often somewhat widened, fills the gap between the angles of the meso- and metasterna. This description will be better understood by referring to the figure of Harpalus, on page 27.

Family LX. CERAMBYCIDÆ.

The long-horned wood-borers constitute one large natural family of beetles, named after the genus Cerambyx, an ancient Greek name for some kind of long-horned beetle, and applied by Linnæus to the insects of this family.

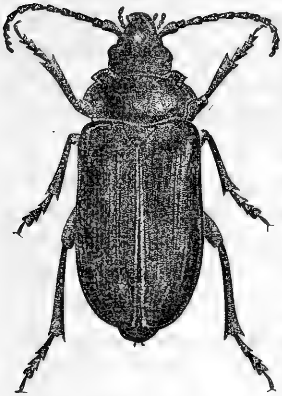
They are divisible into four sub-families, which may be distinguished as follows:

A. Head horizontal or inclined; last joint of palpi not long and pointed; anterior tibæ without furrow. Larvæ six footed.
- B. Head inserted in the thorax; eyes deeply notched or horse-shoe shaped; anterior coxæ not prominent. Larvæ with the head narrower than the body, and retractile.
  - C. Thorax somewhat square-shaped, with a sharp lateral margin, which is usually from one to three-toothed; anterior coxæ strongly transversal. Body generally large and depressed; colors black or brown.........PRIONIDES.
  - C C. Thorax rounded at the sides and without salient margin, sometimes with one spine or tubercle on each side. Size various; colors often bright and diversified.........CERAMBYCIDES.
- B B. Head attached to the thorax by a neck; eyes nearly or quite round; anterior coxæ angular and prominent; elytra generally narrowed behind. Larvæ with the head as wide as the body.........LEPTURIDES.

A A. Head vertical; last joint of palpi cylindrical and pointed; anterior tibiæ usually with a furrow on the inner side. Larvæ footless.........LAMIIDES.

Sub-family PRIONIDES.

[Fig. 72.]

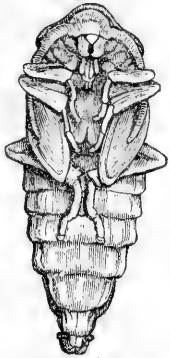


PRIONIS LATICOLLIS, Drury: female—after Riley.

The Prionides are generally large, slow-moving insects, flying only in the evening, and usually of uniform black or brown colors. They are distingushed from the other Longicornes chiefly by their sub-quadrate thorax, the sides of which form a sharp margin, which is usually divided into two or three teeth. The thighs are never clavate or suddenly enlarged at the end, as they are in many of the species of the other sub-families. The eyes are usually coarsely granulated, and the middle cotyloid cavities are widely open on the outer side. Some of the tropical species are of gigantic size, being five or six inches in length. The larvæ are broad and somewhat flattened, and have six very small but distinct feet. They inhabit the trunks and roots of trees.

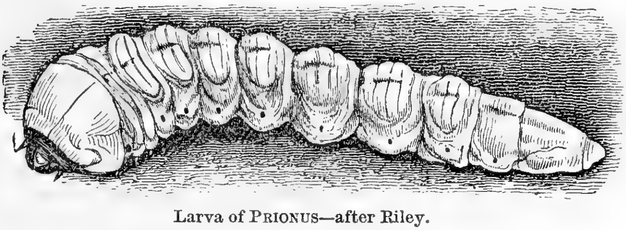
The sub-family is named after the genus Prionus, of Geoffroy, a term derived from a Greek word meaning *a saw*, and applied to these insects on account of the long saw-toothed antennæ of many of the species, especially of the males.

[Fig. 74.]



Pupa of PRIONUS—after Riley.

[Fig. 73.]



Larva of PRIONUS—after Riley.

The following are the principal N. American genera:

A. Antennæ not longer than the thorax; thoracic margin without teeth; tarsi simple....PARANDRA.

A A. Antennæ much longer than the thorax; tarsi spongy beneath, with the third joint bilobed.

B. Eyes coarsely granulated; colors uniform.

C. Thoracic margin prominent; side pieces of the metasternum parallel.

D. Eyes not closely approximate; antennal joints imbricate; teeth of the thoracic margin short and flattened. Body robust ....PRIONUS.

D D. Eyes very large, approximate above and below; thoracic teeth spine-shaped. Body elongate.

E. Thorax much narrowed behind; margin three spined, the anterior spine shortest. 3d joint of the antennæ as long as the 4th and 5th united....DEROBRACHUS.

E E. Thorax nearly square; margin 3-spined, the hindermost spine shortest; 3d joint of antennæ but little longer than the 4th....ORTHOSOMA.

D D D. Eyes very wide apart, but slightly notched; size very large; thoracic margin usually many toothed.

F. First joint of antennæ much shorter than the third....ERGATES.

F F. First joint of antennæ at least as long as the third........................MALLODON.
C C. Thoracic margin almost wanting, with a short spine; side pieces triangular; head vertical..TRAGOSOMA.
B B. Eyes finely granulated; colors variegated; thorax rough, without lateral spine. SPHENOSTETHUS.

Parandra, Latr., contains two species, one of which, the *P. brunnea*, Fab., is common. It is about seven-tenths of an inch long, and of a glossy mahogany-brown color. The other species, *P. polita*, Say, is much more rare. It closely resembles the other, but can be distinguished by its head being as wide as the thorax.

Prionus, Geoff., contains many species. The two most common are the *P. imbricornis* of Linnæus, less than an inch long, of a mahogany-brown color, with long imbricated antennæ, the joints lapping one upon another; and the *P. brevicornis*, or short-horned Prionus, of Fabricius; the antennæ of the female are scarcely a third as long as the body, but those of the male are much longer. This species is black, the male an inch and a quarter, and the female an inch and a half or more in length.

Derobrachus, Serv., contains one large brownish-yellow species found in the Middle and Southern States.

Orthosoma, Serv., contains one common species, the *O. cylindricum*, Fab., a long, narrow, brown insect, an inch and a quarter in length.

Ergates, Serv., has but one species, from California, originally described by Dr. LeConte under the name of *Trichocnemis spiculatus*.

Mallodon, Serv., contains several species, none of which are common.

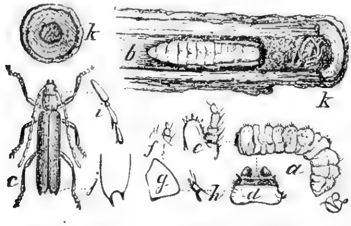
Tragosoma, Serv., contains but one species, the *T. Harrisii*, Lec.

Sphenostethus, Hald., contains but one species, the *S. serripennis*, Haldeman, but previously described by Buquet under the name of *Solenoptera Taslei*. It is of medium size, of a blackish-brown color, and inhabits the Middle and Southern States, but is nowhere common.

Sub-family CERAMBYCIDES.

The Cerambycides are much more numerous and diversified than the Prionides, and are often ornamented with bright and variegated colors. They differ from the Prionides chiefly in having the sides of the thorax rounded, without a salient margin, but sometimes furnished with a single spine or tubercle on each side, and from the Lamiides in having the head sometimes horizontal, but usually more or less inclined, whereas in the Lamiides it is verticle.

[Fig. 75.]



ELIPHIDION PARALLELUM, Newm.: — *a*, larva; *b*, twig split open, showing the enclosed pupa; *k*, the severed end of the twig; *c*, beetle; *i*, basal joints of the antennæ, showing the characteristic spines at the tip of the 3d and 4th joints; *j*, tip of elytron; *d*, *e*, *f*, *g*, *h*, head, maxilla, labium, mandible, and antenna of larva—after Riley.

It must be remarked however that the face may assume a vertical position in the Cerambycides, when the head is bent strongly downwards, but the transition from the occiput to the face is here usu-

ally more gradual and rounded, and in the Lamiides sharper or more abrupt. The face is also rather convex in the Cerambycides, and flat in the Lamiides. This distinction, however, is sometimes unreliable, and the more definite characters stated in the table of sub-families, must be resorted to in cases of doubt. But the minor groups can often be distinguished by their style of coloration, as hereafter specified.

The Cerambycides are often seen resting upon the trunks of trees in crevices of which the females lay their eggs. Some of the smaller species are found upon flowers. Many of them possess the stridulating power described in the general remarks upon this family. The larvæ resemble those of the Prionides in having six very small legs, but they are more cylindrical in their form, and the incisions between the segments are more deeply impressed.

The sub-family of Cerambycides is divided by Lacordaire into two groups, which are primarily distinguished by the difference in the facets or granulations of the eyes. In the first group the granulations are comparatively coarse and the lines between the facets are deeply impressed. In the second group the granulations are much finer, and in many genera the surface of the eyes, unless strongly magnified, appears to be almost plane. But this distinction is only comparative, and can only be appreciated by an actual examination of some of the species in the two divisions.

In the following table we have first separated the group of Asemini, upon the more definite character of the form of the eyes, and then divided the remainder in accordance with the difference in the granulations.

The following is a table of the groups of Cerambycides:

A. Eyes oval, almost entire, or but little hollowed on the inner side (except Tetropium); second joint of antennæ at least half as long as the third; form somewhat depressed; colors obscure: ASEMINI.

A A. Eyes with a deep notch or sinus; second joint of antennæ not half as long as the third.

B. Eyes coarsely granulated. Form moderately convex; antennæ usually as long at least as the body, often much longer in the males; thighs usually slender; colors gray or brown. CERAMBYCINI.

B B. Eyes finely granulated.

C. Form more or less depressed; thighs usually strongly clubbed; colors various.....CALLIDIINI.

C C. Form convex; thighs usually slender or moderately and gradually thickened.

D. Scutellum rounded; size various; colors usually black or brown with transverse yellow or whitish bands..........CLYTINI.

D D. Scutellum triangular and pointed; size large or medium; colors usually black and red: STENASPINI.

The group of ASEMINI contains two principal genera, *Asemum*, Esch., (from the Greek *asemos—obscure*) containing six species of a size a little above medium, with small, hairy, and finely granulated eyes, and *Criocephalus*, Muls., (from *krios—a ram ;* and *kephale*—the *head*) containing nine species of large size, most of them being about an inch in length, with large and less finely granulated eyes, and having from two to four large shallow depressions on the disk of the thorax.

The CERAMBYCINI comprise many genera and species, but the three principal genera east of the Rocky Mountains are *Chion*, Newman, and *Eburia* and *Elaphidion*, Serville. *Chion* contains only the *cinctus*, Drury, and the *garganicus*, Fab., which are now regarded as one species. It is nearly an inch long, of a grayish-brown color, with an irregular oblique yellow band across each elytron, and a sharp spine at the side of the thorax. Its larva inhabits the hickory. The name *Eburia* is derived from the Latin *ebur—ivory*, in allusion to the ivory-like callosities on the elytra. We have ten species, the most common of which is the *E. quadrigeminata*, of Say, an elegant fawn-colored beetle more than three-quarters of an inch in length, with two double ivory-like spots on each elytron. Its larva lives in the honey-locust (*Gleditschia triacanthos*, Linn). *Elaphidion*, (from *elaphus—a stag*, on account of its long horns or antennæ) contains thirty-five plain brownish-gray species, which have been distributed in a number of sub-genera. The larvæ are the well known twig-pruners of the oak, the maple and other trees. The genus is distinguished by having several of the basal joints of the antennæ prolonged into spines at the tip.

The CALLIDIINI are also considerably numerous in species, most of which may be included in the genus *Callidium*, Fab., a name derived from a Greek word meaning beautiful, many of the species being prettily colored. The genus *Hylotrupes*, Serv., meaning a *wood-borer*, is distinguished form Callidium by having the antennæ less than half as long as the body, and by having the thorax densely clothed with short whitish hairs. Its type is the *H. bajulus*, Linn., a dull blackish beetle about two-thirds of an inch in length, which has been imported into this country from Europe. Its larvæ are sometimes seriously injurious to fir, spruce and hemlock lumber, and they have been known to gnaw through sheets of lead when these come in their way. Two beautiful species, one red and the other purple, and both with ivory-like stripes on the elytra, have been set apart in the genus *Physocnemum*, of Haldeman, (*Dularias*, Thomson). *Callidium* proper, (including *Phymatodes*) contains twenty N. A. species.

The CLYTINI constitute a very numerous group which has been divided into many genera, but most of which might be included in the genus *Clytus*. This name, usually attributed to Fabricius, is said by M. Mulsant to have been originated by Laichtining, in a work upon Tyrolese insects. It is derived from the Greek *klutos—sonorous*, or *noisy*—having reference to the squeaking noise made by these insects when captured. The sugar-maple borer (*Clytus speciosus*, Say), the locust borer, (*C. robiniæ*, Forster), and the ash-tree borer (*C. capreæ*, Say,) belong to this group, which contains many of our most beautiful species.

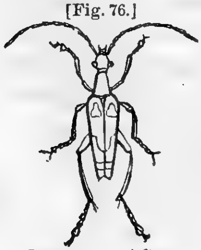
The STENASPINI resemble the Clytini in their convex form, the thorax in both groups being almost globular, but are readily distinguished by their pointed scutellum and their style of coloration, being sometimes velvety-black, with a few large red spots, and sometimes almost wholly red or purple, but with the legs and antennæ black. The group is named from the genus *Stenaspis*, Serv., a word expressive of the narrow and pointed form of the scutellum. The species are usually of rather large size; but one of the most common, the *Batyle suturalis*, Say, is less than half of an inch in length, almost wholly red, and clothed with short erect hairs. The group contains about thirty species, many of which, however, are not found north of Texas.

Sub-family LEPTURIDES.

The Lepturides are named after the genus Leptura, of Linnæus, a term derived from the Greek λεπτος—*slender* or *attenuated*, in allusion to the slender and tapering form of most of the species.

They are distinguished from the other Longicornes by their round eyes, sometimes entire, but usually with a small notch or indentation; by the head narrowed behind the eyes, and the thorax narrowed in front, the union of these two parts giving the appearance of a neck of greater or less length; and by the anterior coxæ being of an angular form and projecting below the level of the breast. The base of the elytra is usually more or less elevated above the level of the thorax. The middle cotyloid cavities are always open, and the eyes are almost always finely granulated. Their form is usually somewhat tapering behind, and as a general rule they are smaller and more active than the other Longicorns, and many of them fly by day, whereas most of the Longicorn beetles are crepuscular. Whilst most Longicorns are found upon the trunks of trees, and often near the roots, many of the Lepturides frequent flowers, especially those of umbelliferous plants.

[Fig. 76.]



LEPTURA:—After Westwood.

It is in this sub-family that the species occur, which have very short or very narrow elytra. But in these cases the wings are not folded under them, as they are in the short-winged Staphylinidæ, but lie at their full length upon the abdomen. The larvæ differ from those of other Longicorns in having the head as wide as the body.

This group is usually placed at the end of the Longicornes, but we retain them here on account of their close alliance with the preceding sub-family of Cerambycides, with which they are united by Lacordaire.

The following are the genera of Lepturides:

A. Wing-cases of ordinary length.
  B. Antennæ knotted, each joint being abruptly enlarged at its extremity............. DESMOCERUS.
  B B. Antennæ uniform.
    C. Eyes entire. Antennæ approximate, and at some distance from the eyes.
      D. Body oblong, depressed, parallel; elytra with elevated lines........................ RHAGIUM.
      D D. Body short and broad, mesosternum prominent, elytra blue..................... GAUROTES.
      D D D. Body oblong and moderately tapering; thorax without tubercles on the sides: ACMÆOPS.
    C C. Eyes with a very shallow notch.
      E. Hind tibiæ with a square excavation at the extremity, and with two long spurs at the upper angle. Shoulders much elevated, elytra tapering.......................... TOXOTUS.
      E E. Tibial spurs moderate and terminal, or sub-terminal. Thorax with obtuse tubercles on the sides. Body moderately tapering... PACHYTA.
      E E E. Body elongate slender, parallel; color blue.................................. ENCYCLOPS.
    C C C. Eyes with a distinct notch; antennæ inserted close to the eyes. Thorax bell-shaped and without tubercles on the sides. First joint of hind tarsi without brush beneath.
      F. Body moderately elongated... LEPTURA.
      F. Body much elongated; abdomen much narrowed at its extremity.......... STRANGALIA.
A A. Wing-cases imperfect.
      G. Wing-cases very short... MULORCHUS.
      G G. Wing-cases nearly as long as abdomen, but slender and separated at their extremities.. STENOPTERUS.

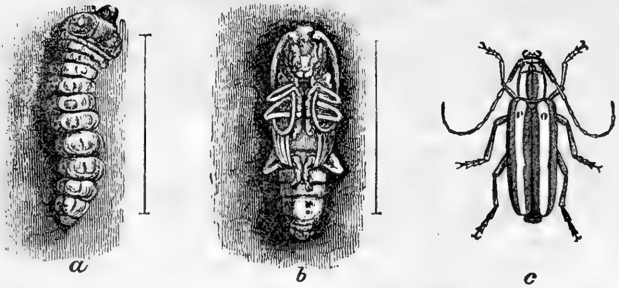
Desmocerus, Serv., contains two species, found on the blossoms of elder, one of which inhabits the Eastern States, and the other is found on the Pacific slope. The former is the *D. palliatus*, of Forster, a beautiful blue insect, eight or nine-tenths of an inch in length, with the basal third of the elytra a light buff-yellow, suggesting the idea of a cloak thrown over the shoulders, and expressed by the specific name *palliatus*. *Acmæops*, Lc., contains thirty-two described species; *Toxotus*, Serv., nine; *Pachyta*, Serv., eleven; *Strangalia*, Serv., seven; and *Leptura*, Linn., seventy-six, besides eleven other species separated by LeConte under the generic name Typocerus. The other genera contain but few species each. The *Rhagium lineatum*, Oliv., is five or six-tenths of an inch long, and of a grayish color. The larvæ burrow between the bark and the wood of the pitch-pine. *Garrotes cyanipennis*, Say, is between four and five-tenths of an inch long. The head and thorax are brownish-black, with an obscure tint of purple; the elytra are much broader than the thorax, and of a metallic greenish-blue color. The *Encyclops cœruleus*, Say, is a small, narrow, linear species, of a dark-blueish color, with reddish eyes. The eyes, as implied by the generic name, are perfectly round and without notch.

Sub-family LAMIIDES.

This sub-family is named from the genus *Lamia*, of Fabricius, a Greek word used to express some kind of bugbear, and suggested as the name of these insects, probably, on account of the menacing aspect of some

of the larger species. They differ from all the other Longicorn beetles, (with a few rare exceptions,) in having their heads vertical, the front

[Fig. 77.]



SAPERDA BIVITTATA, Say ; the Round-headed apple-tree borer :—*a*, larva ; *b*, pupa ; *c*, beetle—after Riley.

or forehead presenting a prominent angle, and the face falling perpendicularly below it, so that when viewed directly from above the face cannot be seen. This position of the head, in connection with their long curved horns, gives to these beetles a fanciful resemblance to a goat, and terms indicative of this similarity often occur in their nomenclature. They are also distinguished by the rather long and spindle-shaped last joint of their palpi, especially the maxillaries, and by a little groove almost always found on the inner face of their tibiæ. The granulations of the eyes, which are usually coarse in the Prionides and fine in the Lepturides, and which serve to separate the Cerambycides into two nearly equal sections, are so variable in the Lamiides as to be of but little value in classification.

These insects generally remain stationary by day upon the trunks and branches of trees, and often escape detection by the resemblance which they bear, in the hues and sculpture of their bodies, to the color and inequalities of the bark on which they repose. Their colors are therefore, as a general rule, less vivid than those of the Cerambycides, their prevailing tints being brown and gray.

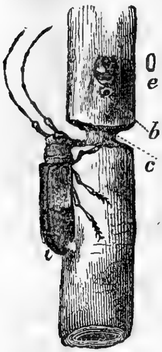
This is the most numerous sub-family of Longicornes, and is said to contain as many genera and species as the other three sub-families united ; but in this country they do not appear to be more numerous than the Cerambycides.

The larvæ resemble those of the Cerambycides in being of a nearly cylindrical form, but a little tapering behind, and considerably swollen at the anterior extremity, with a small head, which is retractile within the enlarged anterior segment. These larvæ differ, however, from those of nearly all other Longicorns in being wholly destitute of legs.

A. Tarsal claws simple; body usually moderately elongated.
  B. Pedicel, or first joint of the antennæ, cicatrised at the end; size large, usually an inch or more in length.......MONOHAMMUS.
  B B. Pedicel without cicatrix or scar.
    C. Middle cotyloid cavities open on the outer side; thorax usually unarmed, or, at most, with an obtuse tubercle at the side; thighs not at all, or but slightly clavate; size usually about medium.
      D. Antennæ two or three times as long as the body, at least in the males; thorax longer than wide.
        E. Antennæ naked; thighs linear, the hinder ones nearly as long as the abdomen: DORCHASCHEMA.
        E E. Antennæ hairy; hind thighs sub-fusiform, not reaching beyond the 2d abdominal segment.......HIPPOPSIS.
      D D. Antennæ never much longer, sometimes shorter, than the body; thorax not longer than wide, (except Adetus.)
        F. Body ornamented with tufts of long hairs; thorax with a tubercle at the side; thighs sub-clavate.......DESMIPHORA.
        F F. Body without tufts of hair.
          G. Head very prominent; upper lobes of the eyes separate or wanting; legs very short: SPALACOPSIS.
          G G. Head and eyes ordinary.
            H. Legs rather long, thighs linear, the hind ones reaching the end of the 4th abdominal segment. Often rather large species.......SAPERDA, 13.
            H H. Legs short; thighs sub-clavate or fusiform, not reaching at most beyond the 3d abdominal segment.
              I. Body robust; antennæ longer than the body; lower lobes of the eyes elongated: ONCIDERES.
              I I. Body more or less elongated; eyes ordinary.
                K. Head retractile; thorax longer than wide; antennæ much shorter than the body; eyes deeply notched.......ADETUS.
                K K. None of the above characters.
                  L. Eyes coarsely granulated; size medium.......ATAXIA.
                  L L. Eyes finely granulated; size small.
                    M. Antennæ hairy; elytra plane.......EUPOGONIUS.
                    M M. Antennæ not hairy; elytra with a rounded elevation at the base: PSENOCERUS.
    C C. Middle cotyloid cavities closed; thorax usually with a small spine or tubercle at the sides; antennæ longer than the body; hind thighs clavate, and reaching nearly to the end of the abdomen. Size usually below medium.
      N. Size about medium; thorax with a spine at the middle of the sides.
        O. First joint of antennæ rather short, and pear-shaped; female without ovipositor: ACANTHODERES.
        O O. First joint of antennæ elongate obconic; female with an exserted ovipositor: GRAPHISURUS.
      N N. Size below medium; body rather short and thick, thoracic tubercle obsolete: LEPTOSTYLUS, 10.
      N N N. Size much below medium; thoracic spine behind the middle of thorax.......LEIOPUS.
A A. Tarsal claws bifid at the end, or with a tooth near the base; body usually elongated and slender; antennæ about as long as, or shorter than the body.
  P. Eyes completely divided; three intermediate segments of the abdomen shorter than the others.
    Q. Claws bifid; body stout; size medium.......TETRAOPES.
    Q Q. Claws toothed at base; body slender; size small.......TETROPS.
  P P. Eyes not divided; body elongated, slender, and parallel.
    R. Four first abdominal segments equal, or gradually decreasing.
      S. Claws bifid.
        T. Hind legs elongated, thighs reaching the end of the 4th abdominal segment: STENOSTOLA.
        T T. Legs moderate, hind thighs not reaching the end of the 3d abdominal segment.......PHYTŒCIA.
      S S. Claws toothed at base; legs short.......OBEREA, 13.
    R R. Three intermediate segments of abdomen shorter than the others; head retractile.......AMPHIONYCHA.

Monohammus, Serv., contains ten described species. The antennæ of the males are about twice as long as the body, and in some species more than this, and the anterior legs are longer than the others, and their tarsi are strongly fringed with hairs. Certain species with shorter antennæ, and with the fore-legs of the males not elongated, have been separated by LeConte in the genus or sub-genus Goes. The genus *Ptychodes*, Serv., not given in the table, has most of the characters of Monohammus, but the thorax is rounded at the sides and without a lateral spine; but one species inhabits the United States; two others are found in Mexico and Central America. The genus *Saperda*, Fab., contains thirteen N. A. species, including the well known round-headed borer of the apple tree. *Leptostylus*, LeC., contains ten species, the most common of which is the *L. aculiferus*, Say, between three and four-tenths of an inch long, and of a gray color; thorax uneven; elytra rough with elevated points, with a brownish tip which is separated from the gray portion by a transverse whitish band. *Liopus*, Serv., contains many small species not averaging more than a quarter of an inch in length. Dr. LeConte makes the discriminative remark that in this genus and its allies, the lateral tubercle of the thorax becomes more acute and spiniform the farther back it is situated. The genus *Oberea*, Mulsant, contains thirteen species in our fauna, some of which are injurious to the raspberry, in their larva state. The other genera given in the preceding table contain but few species. *Oncideres*, Serv., contains three North American and many South American species. The only species found east of the Mississippi river is the *O. cingulatus*, Say, commonly known as the Twig-girdler, from the habit of the female of girdling twigs below the point where she has deposited her eggs. It usually breeds in the hickory, but it has been known to girdle the twigs of the apple, the pear, and the persimmon. We have referred above to the twig-pruning habits of the species of Elaphidion among the Cerambycides; but in that case, the pruning is done by the larvæ, whereas the amputation of the Oncideres is performed by the parent insect. *Tetraopes*, Dalman, contains the well known brick-red beetles with black spots, found on different species of Asclepias, or milk-weed. They are peculiarly N. American, the species being widely distributed from the Atlantic States to California.

[Fig. 78.]



Oncideres cingulatus, Say:—The Twig-girdler; *b*, hole made in depositing its egg; *e*, egg, natural size—after Riley.

TRIBE XIX.

TETRAMEROUS PLANT-BEETLES.

Herbivora tetramera. PHYTOPHAGA, Kirby.

This tribe embraces an extensive series of beetles, mostly of small size, not averaging much above a quarter of an inch in length, and rarely exceeding half an inch, and usually adorned with beautiful and often variegated colors. Like most other beetles of the tetramerous section, the tarsi are clothed with a brush of hairs beneath, and the third, or last joint but one, is usually more or less deeply bilobed. They are distinguished from the snout-beetles in the same section, by the absence of a rostrum or beak; from the short-horned borers, by their strongly dilated and bilobed tarsi, and from both by the antennæ not being knobbed at the end. They differ from the other family of tetramerous beetles—the long-horned wood-borers—in the comparative shortness of their bodies and of all their members, especially the antennæ, which are never tapering as they are in most of the Cerambycidæ, but are either filiform or slightly and gradually enlarged towards the tip. Some of the Cerambycidæ, however, have filiform antennæ, and there seems to be no character by which these two tribes can be absolutely distinguished from each other; and the genus Donacia occupies so intermediate a position between them that it has been placed sometimes in one, and sometimes in the other. But notwithstanding their close approach in a few of the connecting genera, scarcely any families of beetles are ordinarily more easily distinguished by their general form and aspect. The insects of the present tribe are pre-eminently phytophagous or plant-eating in their habits, both in the larva and imago states. The only beetles which can be compared with them in this respect are the chafers or leaf-eating Lamellicorns in the pentamerous section. We have had occasion, in the introductory part of this work, to state some of the differences in the habits of these two plant-eating tribes.

The Lamellicorns are, for the most part, much larger insects. They feed mostly upon the foliage of trees, in the beetle form, whilst their larvæ live under ground upon the roots of grasses and other plants; and they feed in the evening, clinging to the leaves by means of their long, sharp claws.

The tetramerous plant-beetles, on the contrary, are comparatively small insects; they feed mostly upon herbaceous plants, both in the larva and beetle state; they are diurnal in their habits, and move slowly over the surface of plants, to which they adhere by means of the dense brush of hairs on the under side of their feet.

The larvæ are for the most part short, fleshy, convex or hump-backed grubs, usually living upon the surface of the leaves upon which they feed, often in company with the mature insects. They have six thoracic legs, and usually a fleshy terminal proleg. Living exposed to the light they differ from the great majority of Coleopterous larvæ in being more or less highly colored. Some of them have the singular habit of protecting themselves by a covering of their own excrement, which will be described more fully in treating of the sub-family of Cassidides. But a considerable proportion of them are internal feeders. Some are leaf-miners; others inhabit the roots of herbaceous plants; and the larvæ of Donacia live concealed in the stems of water-plants, thus confirming their affinity with the preceding wood-boring tribe. These last mentioned larvæ exhibit a habit extremely rare amongst the Coleoptera, but which we have seen to be possessed by a few of the Curculionidæ, that of enclosing themselves in silken cocoons, when about to change to the pupa state. These cocoons are sometimes found fastened in a row to the stems of the aquatic plants in which the larvæ reside. Some phytophagous larvæ change to pupæ, attached to the leaves, but many of them go into the ground.

Being, as their name implies, pre-eminently plant-eaters, this tribe of beetles occupies a prominent place in practical entomology, on account of the many species which are injurious to the agriculturalist. Among these are the Striped cucumber-beetle, and its root-boring larvæ; the cabbage and turnip flea-beetles; the flea-beetle of the vine; and the tortoise-beetles which feed upon the sweet potato.

When danger threatens, the Chrysomelidæ do not usually attempt to escape either by running or flying, but, like the Curculionidæ, seek safety by contracting their limbs and falling to the ground.

With regard to the size of these insects, as compared with the Coleoptera in general, the same statement is applicable which we made above in treating of the Curculionidæ, and the terms large and small must be understood as being similarly modified; that is to say, half of an inch, which is about the medium length of beetles in general, is *large* when applied to the insects of these two families, quarter of an inch is *medium*, and an eighth of an inch or less is *small* or *very small*.

Family LXI. CHRYSOMELIDÆ.

This family, as here constituted, comprises the whole of the tribe of tetramerous plant-beetles. It is made up of several groups, some of which are sufficiently distinct, whilst others are more closely allied, thus rendering a natural classification of them indefinite, from the doubt whether certain groups should, or should not, be raised to the rank of sub-fami-

—21

lies; and accordingly authors have differed much as to the number of primary divisions. Linnæus, having included Donacia in the long-horned genus Leptura, described the remainder of the present tribe under the three genera, Hispa, Cassida and Chrysomela. And if we take these, as we do most of the Linnæan genera, as types of families, it may well be questioned whether any more obvious or natural classification of these insects can be suggested to-day.

Latreille, in the Règne Animal, divided them into two families, which he designated by the names *Eupoda*, signifying largely developed legs; and *Cyclica*, in allusion to the circular or rounded form of most of the species. The former includes Donacia, Crioceris and the exotic genus Sagra. The more extensive family of Cyclica he divided into three tribes, which are equivalent to our sub-families, viz: the Cassidariæ, the Chrysomelinæ, and the Galerucitæ. These divisions he founds partly upon the habits of the larvæ, which he divides into four kinds: 1st, those which cover their bodies with their excrement, (Cassidariæ); 2d, those which live exposed on leaves, (Chrysomelinæ proper); 3d, those which inhabit tubes which they drag about with them, (Cryptocephalus and certain other genera of Chrysomelinæ); and 4th, those which live concealed in the interior of leaves, feeding on their parenchyma, (Haltica, and its sub-genera, among the Galerucitæ).

This arrangement of Latreille seems to us much less natural and satisfactory than are usually the classifications of this eminent entomologist. By it the small division of Eupoda is made to hold a rank equivalent to all the rest of the Chrysomelidæ combined, and yet its most common and numerous genera (Crioceris, Orsodacna, etc.), bear a close resemblance to some of the Galerucides, and do not differ from many of the Cyclica, either in form or the habits of their larvæ, so much as the sub-family of Hispides. Moreover, the family name of Eupoda applies with but little force to many of these common species, though it is very appropriate to some of the foreign genera. With respect to the habits of the larvæ, however interesting in themselves, they furnish a very imperfect basis of classification, since most of the habits above referred to are common to several of the sub-families.

Mr. Westwood admits four primary divisions, which he raises to the rank of families, viz: Crioceridæ, Cassididæ, Galerucidæ, and Chrysomelidæ. Dr. LeConte has published a number of able papers upon the Chrysomelidæ of North America, but being scattered through various scientific periodicals, they are not very accessible to the general student.

In a recent volume of the Proceedings of the Academy of Natural Sciences, of Philadelphia, Mr. G. R. Crotch, with the assistance of Drs. LeConte and Horn, and with the aid of their extensive cabinets, has published a pretty full synopsis of the Phytophaga of the United States,

which I have found of much use in preparing the following tables of genera. Mr. Crotch unites all the Phytophaga in the family of Chrysomelidæ, which he divides into ten sub-families, as follows: Donaciides, Orsodacnides, Criocerides, Melolonthides, Cryptocephalides, Chrysomelides, Eumolpides, Galerucides, Hispides and Cassidides.

The Orsodacnides do not seem to us to be sufficiently distinct from the Criocerides, nor the Melolonthides (questionably so called) from the Crytocephalides, nor the Eumolpides from the Chrysomelides, to be retained as of equal rank. We will therefore divide the Chrysomelidæ into the seven following sub-families. The accompanying tables of the minor groups exhibit a pretty full synopsis of N. American genera, excepting a few which are composed of but one or two rare species, usually from the remote West:

A. Body elongated; thorax not margined at the sides; head slightly constricted behind the eyes; eyes prominent; thighs usually more or less thickened.
- B. Body much elongated; first ventral segment very long; larvæ live in the stems of plants... .... DONACIIDES.
- B B. Body moderately elongated; first ventral segment not much longer than the others; larvæ live on the leaves of plants, sometimes cover themselves with excrement .... CRIOCERIDES.

A A. Body more or less rounded (except Hispides); thorax almost always margined; head not constricted; eyes not prominent; thighs not swollen (except in Haltica and its sub-genera.)
- C. Antennæ distant, being wider apart at base than the length of the first joint.
  - D. Body oval; abdomen wholly covered by elytra; larvæ live exposed on leaves .... CHRYSOMELIDES.
  - D D. Body usually short and sub-cylindrical; tip of abdomen vertical and uncovered; larvæ live on leaves, in portable cases. CRYPTOCEPHALIDES.
- C C. Antennæ approximate, being rarely wider apart than the length of the first joint.
  - E. Antennæ filiform and at least half as long as the body; hind thighs, in one division, enlarged for jumping; larvæ live on leaves or between their laminæ .... GALERUCIDES.
  - E E. Antennæ less than half as long as the body, and more or less thickened towards the tip.
    - F. Head exposed; form oblong and usually sub-quadrate; surface usually strongly pitted or reticulated; larvæ live between the laminæ of leaves .... HISPIDES.
    - F F. Head concealed under the thorax; form hemispherical; surface usually smooth; larvæ live on leaves, covered by excrement: CASSIDIDES.

Sub-family DONACIIDES.

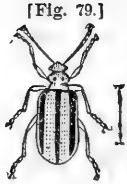
This sub-family, composed mostly of the genus *Donacia*, Fab., forms a connecting link between the Lepturides of the preceding family and the Criocerides of the present. Their form is considerably elongated, and they can be distinguished with certainty by the unusual prolonga-

tion of the first ventral segment, which is as long as all the others combined. They are between a quarter and half of an inch in length, and with a dark metallic lustre, of a greenish, bronze or purplish hue. The under side is paler, and clothed all over with an extremely fine silken prostrate pubescence, which enables them to shed the water, when the aquatic plants upon which they reside happen to be submerged. The species often closely resemble each other, rendering it difficult to draw the line between species and varieties. The larvæ inhabit the stems of aquatic plants. When about to transform, they enclose themselves in silken cocoons, which are sometimes attached in rows upon the outside of the plants.

Mr. Crotch enumerates twenty-five species as inhabiting the United States, two of which he describes as new, and refers the reader for a full description of the others to Dr. LeConte's Synopsis in the Proc. Acad. Nat. Sc., of Philadelphia, for the year 1852.

Sub-family CRIOCERIDES.

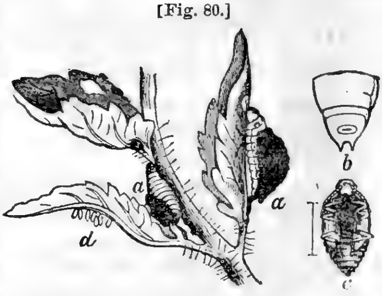
[Fig. 79.]



CRIOCERIS (LEMA) TRILINEATA, Oliv.

This sub-family takes its name from the genus *Crioceris*, of Geoffroy, a word which literally means a *ram's horn*, but which is not especially appropriate to these insects, unless it be by way of expressing their relationship to the preceding family of Cerambycidæ, in which the resemblance of the antennæ to the horns of the ram and the goat is much more striking. Like them, also, some of the beetles of the present sub-family have the faculty of making a squeaking noise, by the friction of one part of their bodies upon another. The Criocerides differ from the great majority of Chrysomelidæ, in having the thorax almost cylindrical and without a lateral margin, and more decidedly narrower than the abdomen. The antennæ are somewhat moniliform, of the same width throughout, and about half as long as the body. The larvæ live exposed on the leaves upon which they feed; but some of them, of which the common Three-lined potato-beetle is an example, have the remarkable habit of protecting themselves by a covering of their own excrement. To enable them to accomplish this purpose, the anal opening is upon the upper side of the last segment, and the excrement is pushed forwards upon the back by the pressure of that which is subsequently evacuated. The Criocerides of this country are contained in two leading genera:

[Fig. 80.]



LEMA TRILINEATA, Oliv.:—*a a*, larvæ; *c*, pupa; *d*, eggs; *b*, two last segments of the larva, showing the anal aperture on the upper side of the last segment—after Riley.

A. Last joint of palpi widened and truncated; claws toothed.............................ORSODACNA.
A A. Last joint of palpi not wider than the others and pointed; claws simple..............CRIOCERIS.

Orsodacna, a name taken from the Greek and meaning a *bud-gnawer*, was originally applied to some insect now unknown, which was injurious to fruit trees. It includes three sub-genera: *Orsodacna*, Latr., having the thorax uniform and the eyes entire; *Zeugophora*, Kunze, having the eyes notched and the thorax with a lateral tubercle; and *Syneta*, Esch., with several short teeth at the sides of the thorax. The species are of moderate size, and either blackish or dull yellow, but more commonly with both of these colors combined. We have twelve species, some of which are very variable, and have been described under different names. The only species of Crioceris proper found in the United States, is the imported asparagus beetle, *Crioceris asparagi*, Linn., which has become naturalized in some of the Eastern States. Most of our species are now placed in the sub-genus *Lema*, Fabr., as restricted by Lacordaire, and distinguished by having the thorax constricted or narrowed a little behind the middle. The most common species is the *Lema trilineata*, Olivier, or the Three-lined potato-beetle, a quarter of an inch long, yellow, with three black stripes on the elytra. Mr. Crotch enumerates twelve other species, most of which inhabit the Southern States.

Sub-family CHRYSOMELIDES.

This sub-family is founded upon the typical genus *Chrysomela*, of Linnæus, a word which literally means a *golden apple*, and which was obviously given to these insects in allusion to their rounded form and beautiful colors, which not unfrequently exhibit a golden hue. Their most distinctive scientific character, as compared with the other sub-families of this tribe, is the distance from each other of the antennæ at their points of attachment, being always farther apart than the length of the first joint, and often two or three times as far, taken in connection with the gradual but slight enlargement of these organs towards the tip. The sub-family comprises two well-marked groups, which are regarded by some entomologists as distinct sub-families, and which may be designated by the terms of Chrysomelini and Eumolpini. In the former the thorax is transversal, that is, wider than it is long, strongly margined, and as wide at base as the elytra; the antennæ are moderately robust, sub-moniliform, and almost always less than half as long as the body; the anterior coxæ are transverse; the 3d joint of the tarsi

[Fig. 81.]

CHRYSOMELA (MYOCORYNA) JUNCTA, Germar:—*a*, eggs; *b b*, larvæ; *c*, beetle; *d*, wing-cover; *e*, anterior leg—after Riley.

is scarcely bilobed, and the claws are usually simple. In the latter, the thorax is very convex, narrower than the abdomen, and with the margin indistinct or wanting; the antennæ are slender, almost filiform, and about half as long as the body; anterior coxæ globose; the third joint of the tarsi is deeply bilobed, and the claws are bifid.

The larvæ live exposed on the leaves of herbaceous plants, upon which they feed. We do not know of any larva in this sub-family which covers itself with excrement, unless we admit into it the intermediate genus *Blepharida*, which we have preferred to unite with the other saltatory species.

The following are the genera of *Chrysomelini:*

A. Third joint of tarsi entire or slightly notched at the end; posterior episterna usually narrowed behind.
- B. Form regularly oval and strongly convex; tarsi entire; color usually yellow, with darker stripes or spots; length between a quarter and a half of an inch........................ CHRYSOMELA.
- B B. Form oval or oblong oval, convex; third joint of tarsi notched; color metallic-green or blue; length less than quarter of an inch........................ GASTROPHYSA.
- B B B. Form short and round or sub-globuse; dark metallic without spots; length much less than quarter of an inch........................ PHÆDON.
- B B B B. Form oblong, narrow, parallel, depressed; antennæ strongly clavate; dark metallic, with a few yellow stripes; length much less than quarter of an inch.............. PRASOCURIS.

A A. Third joint of tarsi deeply bilobed; posterior episterna parallel; form oblong oval and depressed; colors various; size same as Chrysomela........................ PLAGIODERA.

The following are the genera of *Eumolpini:*

A. Body smooth and shining.
- B. Thorax lobed behind the eyes.
  - C. Elytra irregularly punctured; claws with a tooth beneath.
    - D. Antennæ robust, somewhat clavate; color golden-green or blue; length a third of an inch or more........................ CHRYSOCHUS.
    - D D. Antennæ long and filiform; color golden-green or bronze; length a quarter of an inch or less........................ TYPOPHORUS.
  - C C. Elytra punctured in rows; claws bifid; size small; color brown with black spots, rarely wholly black........................ PARIA.
- B B. Thorax not lobed behind the eyes.
  - E. Second joint of the antennæ shorter than the third; elytra densely but irregularly punctate........................ COLASPIS.
  - E E. Second and third joints of antennæ equal; elytra punctured in rows...... METACHROMA.

A A. Body more or less clothed with hair or scales.
- F. Thorax without a margin at the sides.
  - G. Body shining, bronze, rarely green; punctures indistinct; sparsely haired.. HETERASPIS.
  - G G. Body obscure, brown, coarsely punctured.
    - H. Thorax longer than wide; body densely haired; size about medium.......... FIDIA.
    - H H. Thorax wider than long; body moderately haired; size small........ XANTHONIA.

The genus Chrysomela has been divided into a number of sub-genera which can generally be distinguished by their style of coloration, as follows: *Labidomera*, Chevr., dark-yellow, with a few large blue-black spots; *Myocoryna*, Stäl., usually with the elytra pale-yellow, with four or five darker stripes on each; *Zygogramma*, Chevr., elytra with two or three stripes more or less united; *Calligrapha*, Chevr., elytra with numerous irregular lines and dots; and *Chrysomela*, Linn., blackish or golden, without stripes; but there are some exceptions to these general

rules which we shall notice below. *Labidomera* contains one common species, the *L. trimaculata*, Fab., found on milk-weed. *Myocoryna* contains the destructive potato-beetle commonly known as the *Doryphora* 10-*lineata*, and the allied but much less common species *D. juncta*, and two other similar species found in Texas and Mexico. The generic name *Doryphora*, means a *spear-bearer*, in allusion to the pointed anterior prominence of the mesosternum, and was originally applied by Illiger to a similar group of insects from South America. But in our species the mesosternum is not produced to a point, and therefore M. Stäl, a Sweedish entomologist, has formed a new genus for them under the name of Myocoryna, from the Greek *mus*—to *compress*, and *koruna*, a *club*—the club of the antennæ being slightly flattened.

This is one of the exceptional genera with respect to color, being usually striped, but one species is wholly blue, and another is wholly red. *Zygogramma*, implying literally that the *stripes* are united or *yoked together*, contains a number of common species which are subject to considerable variation. *Calligrapha*, meaning *beautiful writing*, contains some of our most elegant beetles, distinguished by the numerous metallic marks and dots on their almost white elytra. The species are numerous and often variable. Mr. Crotch admits thirteen species as inhabiting the United States; a few of them depart from the normal style of coloring, and resemble *Zygogramma*. The organic distinction between the two genera is, that in *Zygogramma* the claws are approximate and the claw joint toothed beneath; and in *Calligrapha*, the claws are distant and the claw joint simple.* *Chrysomela* proper is now restricted to a small number of dark colored species, some of which have a golden lustre. One species from Colorado and the neighboring States is black, with a yellow border to the elytra.

Gastrophyza, Chev.,—meaning *abdomen inflated*—alludes to the remarkably swollen condition of the abdomen of the females when filled with eggs. It contains one of our prettiest and most common beetles: the *G. polygoni*, Linn., common to both Europe and this country. It is three-twentieths of an inch long, of a brilliant blue-green color, with a yellow thorax. It feeds upon the common knot-weed (*Polygonum aviculare.*) Mr. Say described it as a rare insect under the name of *Chryso-*

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*It is a question whether in grouping certain insects—such, for example, as the Chrysomelides—the plan of coloration should not have more weight, in comparison with slight organic characters. It is evidently unnatural to separate such species, with striped elytra, as *elegans*, Olivier, and *similis*, Rogers, from the similarly marked *Zygrogramma pulchra* and *exclamationis*, Fab., and *conjuncta*, Rogers, and unite them with the dissimilar and dotted group of Calligrapha, upon a character so variable, and therefore unimportant, as is the structure of the tarsal claws, in the whole family of Chrysomelidæ.

But we have been gratified to see, since the above was written, that Mr. Crotch, in his recent Check-list of Coleoptera, has suppressed all these sub-genera, and recognized them only as sections of the original genus Chrysomela, of Linnæus; a course which, it seems to us, might be profitably adopted with respect to many modern genera.

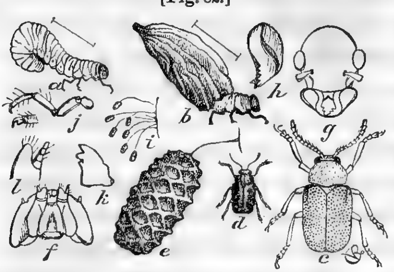
mela cœruleipennis. Say also described two other and similar species, but without the yellow thorax, which he accredits to the Missouri territory. *Phædon*, Chev., contains a few small species, the type of which is the *P. viride*, of Melsheimer. *Prasocuris*, Latr., contains three species, none of which are common. *Plagiodera*, Chev., is composed of a number of species of very variable color, and even the same species, as in the cases of the not uncommon *P. scripta* and *P. interrupta*, which are ordinarily yellow with blackish spots, are sometimes found wholly blue-black or green. This genus was formerly known as *Melasoma*, Dillwyn; but the name is not properly applicable to the species, and besides was pre-occupied by Latreille—as we have seen in a former part of this work—as the general name of the black-bodied heteromera. It has been therefore replaced by *Plagiodera*, Chevrolat, meaning *transverse thorax*, and applied to them because the thorax is much wider than it is long.

Chrysochus, Chev., in the group of Eumolpini, meaning literally a *goldsmith*, is the generic name of the beautiful golden-green beetle, about four-tenths of an inch long, found on the dogs-bane and other species of *Apocynum*. It has usually been referred to the genus Eumolpus, but is now known as the *Chrysochus auratus*, Fabr. It is common throughout both the Eastern and Western States, and has been found as far west as Arizona. Another similar species, but usually a little larger and of a deep blue-green color, has been found in Oregon and California. It is the *Ch. cobaltinus*, of LeConte. *Typophorus*, Chev., contains three closely allied species, the type of which is the *T. tricolor*, Fab., found in the Middle and Southern States. The next five genera—*Paria*, *Colaspis*, *Metachroma*, *Heteraspis* and *Xanthonia*—contain a large number of small, brown insects, though some species of Colaspis have a metallic lustre. *Paria* is distinguished from the others by the ear-like lobes on the anterior margin of the thorax, which partly cover the eyes. The same lobes exist in Chrysochus, but are situated lower down. The genus *Fidia*, of Dejean, is composed of a somewhat larger species, of a dark chestnut or blackish color, but with a mealy surface produced by dense, short, prostrate hairs. The insects of this genus have an economic interest in consequence of damage done by them to the leaves of the grape-vine. The leading type is the *F. viticida*, Walsh. Dr. LeConte regards the *longipes*, Mels., and the *viticola*, Uhler, as only varieties of this species.

Sub-family CRYPTOCEPHALIDES.

This group is founded upon the genus *Cryptocephalus*, of Geoffroy, a term meaning *concealed head*, and given to these insects because the head is so deeply immersed in the strongly convex thorax that it can be scarcely or not at all seen when viewed from above. The pygidium

[Fig. 82.]



COSCINOPTERA DOMINICANA:—*a*, larva extracted from case; *b*, do. with case; *c*, beetle showing punctures; *d*, same natural size; *e*, egg enlarged; *f*, head of larva, under side; *g*, head of male beetle; *h*, jaw of same; *i*, eggs natural size; *j*, leg of larva; *k*, jaw of same; *l*, maxilla of same—after Riley.

or last segment of the abdomen is bent vertically downwards, and left uncovered by the elytra, furnishing an easily distinguishable character which is common to nearly all the species, except those specified in the following synopsis, and which is found in none of the other sub-families. The antennæ are rather distant at their insertion, sometimes short and serrate, but in the majority at least half as long as the body, and very slender and filiform. The third joint of the tarsi is always deeply bilobed. They are all small insects, rarely attaining a quarter of an inch in length. All the larvæ, we believe, so far as known, live upon the surface of leaves, and have the curious habit of enclosing themselves in compact cases, composed of their own excrement, which they mould into shape by means of their mandibles. The same habit of economizing the particles of excrement is practiced by many of the small caterpillars belonging to the lepidopterous family of Tineidæ. The larvæ carry their cases about with them, by protruding the anterior part of their bodies through the open extremity. When about to transform they attach their cases to the twigs, and close the opening, thus making them answer the purpose of a cocoon.

A. Antennæ serrate or sub-clavate, and shorter than the head and thorax.
  B. Body elongate; abdomen wholly covered by elytra; antennæ serrate.................. ANOMŒA.
  B B. Body short, oval or subcylindric; tip of abdomen exposed.
    C. Body short, thick and tuberculous; antennæ small, sub-clavate and sub-serrate; legs closely contractile.................. CHLAMYS.
    C C. Body not tuberculous; antennæ free; legs not contractile.
      D. Tip of abdomen scarcely exposed; elytra smooth and shining, finely punctured; antennæ sub-serrate.................. BABIA.
      D D. Tip of abdomen fully exposed; elytra coarsely punctured or pubescent.
        E. Antennæ sub-serrate; elytra densely punctured.................. SAXINIS.
        E E. Antennæ serrate; elytra irregularly punctured and pubescent; mandibles large: COSCINOPTERA.
A A. Antennæ slender and filiform, and longer than the head and thorax.......... CRYPTOCEPHALUS.

The genus *Anomœa*, Lacord., has for its type the common *A. laticlavia*, Forster, from a quarter to a third of an inch in length, and of a clay-yellow color, with the suture and margin of the elytra black. The generic name means *dissimilar*, in allusion to the departure of the species from the ordinary characters of the sub-family, but their place here is determined by the serrate antennæ, and more especially by the case-bearing habit of their larvæ. Another species very differently colored is found in Texas. The species of *Chlamys*, Knoch, are of a dark brown color, and when their limbs are contracted they resemble little rough balls of inanimate matter. The most common species is the *C. plicata*,

Fab., three-twentieths of an inch long. A much smaller species, the *C. dispar*, Lacord., has been placed in the sub-genus *Exema*. *Babia*, Chev., is founded upon the *B. biguttata*, Oliv., and its varieties. It is about three twentieths of an inch long, blue-black, with a fulvous spot on the shoulder, and another at the tip of each elytra. It differs from the great majority of Cryptocephalides in having the tip of the abdomen but slightly, and in many specimens not at all exposed. *Saxinis omogera*, Lacord., resembles the last mentioned insect in size and color, except that there is no spot at the end of the elytra. It is found in the Southern States and Texas. The genus contains but one other North American species. The type of the genus *Coscinoptera*, Lacord., is the *C. dominicana*, Fab. (Fig. 82), two-tenths of an inch long, or a little more, black, rather densely covered with a fine ash-colored pubescence. Several other species have been found in the remote Western States. The *C. vittigera*, LeC., found in Kansas, is more oblong, and each elytra has a fulvous stripe, which is bent up like a hook at the end. The generic name comes from *koskinos*—a *sieve*, and *ptera*—wings, referring to the irregularly distributed punctures, somewhat like the holes in a sieve. The genus *Cryptocephalus* contains many more species than all the others combined. It has been divided into a considerable number of sub-genera, mostly upon slight or obscure characters. A more convenient distribution, for the purpose of identification of species, could be made in accordance with their colors. The majority are brown, with yellow stripes or spots; a considerable number are blue-black, with rufous or orange spots; and some of the smallest species are wholly blue-black or brown.

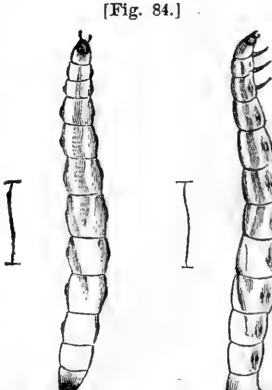
Sub-family GALERUCIDES.

[Fig. 83.]

GALERUCA (DIABROTICA) VITTATA, Fa.: The Striped cucumber-beetle.

Named after the genus *Galeruca*, of Geoffroy. They are distinguished primarily from the other Chrysomelidæ by the approximation of the antennæ at their points of insertion, being rarely farther apart than the length of the first joint, and from the Chrysomelides proper by having the antennæ perfectly filiform, or not enlarged towards the tip. The thorax is narrower than the elytra, which, together with a similarity of coloring, gives to some of the species a strong resemblance to the Criocerides, but they can always be distinguished by the thorax having a distinct lateral margin or edge. It is in this sub-family that we find a large

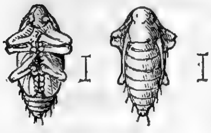
[Fig. 84.]



DIABROTICA VITTATA:—Larva greatly magnified, the side lines showing the length of the fully grown larvæ; 1, back view; 2, side view—after Riley.

proportion of the injurious Chrysomelidæ, such as the Striped cucumber-beetle, and the various species of flea-beetles, so injurious to the vine, the cucumber, and the Cruciferæ, or plants of the cabbage and turnip family; and they furnish a remarkable exception to noxious insects in general by being usually most injurious in the perfect or beetle form. But some of them, like the Cucumber-beetle, (*Diabrotica vittata,*) also cause the death of the plants by burrowing into the roots in their larva state. Some of the species, like the European *Galeruca calmariensis*, and the little bronze flea-beetle, *Haltica helxines*, which is common to Europe and this country, depart from the usual habits of the family in devouring the foliage of trees, whereas the great majority of Chrysomelidæ feed upon herbaceous plants. The habits of the larvæ are various, those of Galeruca feeding exposed upon the surface of leaves; those of Diabrotica boring into roots, and those of Haltica sometimes feeding upon roots, but usually mining between the laminæ of leaves.

[Fig. 85.]



1. 2.

DIABROTICA VITTATA.:—Pupa; 1, ventral; 2, dorsal view—after Riley.

The sub-family is divided into two distinct groups: the *Galerucini*, with the thighs not thickened, and the anterior coxæ not separated by the prosternum; and the *Halticini*, having the anterior coxæ separated by a projection of the sternum, and the hind thighs greatly enlarged, which gives them the power of jumping, and from which the name of *flea-beetles* is derived. The following are the principal genera:

A. Hind thighs not thickened. (*Galerucini.*)
B. Thorax wider than long; first joint of antennæ shorter than the second and third united; color usually dull brownish, sometimes with black stripes.................GALERUCA.
B B. Thorax almost square, with rounded corners; first joint of antennæ as long as second and third united; colors usually yellow and black combined.................DIABROTICA.
B B B. Thorax usually a little wider than long; second and third joints of antennæ about equal; size small; color brown or metallic black, or blue, and without spots.................LUPERUS.
A A. Hind thighs enlarged for jumping. (*Halticini.*)
C. Antennæ distant, slightly thickened towards the tip; claws bifid.................BLEPHARIDA.
C C. Antennæ approximate, filiform, claws simple or dentate.
D. Last joint of hind tarsi swollen.
E. Elytra glabrous; size about medium; colors various.................ŒDIONYCHIS.
E E. Elytra hairy; size small; color brown.................HYPOLAMPIS.
D D. Last joint of hind tarsi not inflated.
F. Elytra irregularly and finely punctured; size medium or small.
G. Body oval; thorax wider than long.
H. Thorax with an impressed transverse line before the base; color blue-black: GRAPTODERA.
H H. Thorax without impression.
I. Tarsi of ordinary form.
K. Second joint of antennæ shorter than the third; size medium; colors various: DISONYCHA.
K K. Second and third joints of antennæ equal; size small; color dark metallic; elytra usually with one yellow stripe.................ORCHESTRIS.
I I. First joint of hind tarsi as long as the others united, size very small; color brownish.................LONGITARSUS.
G G. Body elongate; thorax about as long as wide; size small; color black, sometimes striped with yellow.................SYSTENA.

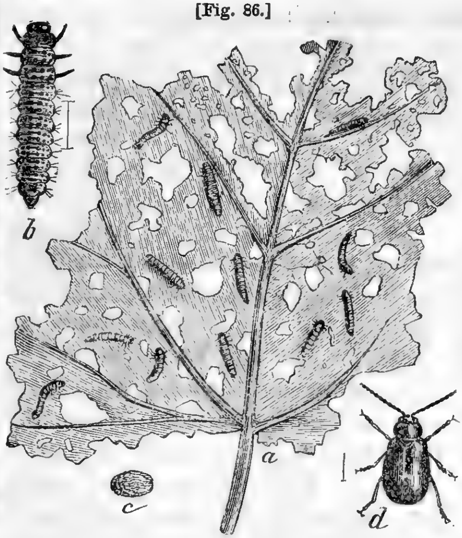
F F. Elytra punctured in rows; size very small, without spots or stripes.
- L. Antennæ with eleven joints; hind tarsi normal.
  - M. Hind tibiæ robust, and terminated by a bifid spur; body perfectly oval; head deeply immersed in the thorax; size small; color brassy-black... DIBOLIA
  - M M. Hind tibia toothed and furrowed on the outer side; very small; blue or brassy..... CHÆTOCNEMA.
  - M M M. Hind tibia normal; thorax with a deep impression near the base; color dark metallic or reddish..... CREPIDODERA.
- L L. Antennæ ten-jointed; hind tarsi attached to the side of the tibia: PSYLLIODES.

Galeruca, Geoff., contains a considerable number of species, some of which are common but inconspicuous. *Diabrotica*, Chevr., has been divided into a number of sub-genera, agreeing in size and form, but the more common species are readily distinguished by their color, *Diabrotica* proper being usually pale yellow with black spots or stripes, *Phyllobrotica*, Dej., being tawny or orange with black spots or stripes, and *Phyllecthrus* being blue black with a yellow thorax. Diabrotica means one that *gnaws through*; Phyllobrotica, a *leaf-gnawer*; and Phyllecthrus, a *leaf-enemy*; all of which terms have reference to their leaf-eating and often destructive habits.

The Striped cucumber-beetle is the *D. vittata*, Fab. *Luperus*, Geoffr., also meaning *injurious*, contains a few small species, some of which are of rich metallic colors; but none of our species are sufficiently numerous to be injurious. *Blepharida*, Chev., forms a connecting link between Haltica and Chrysomela, having the oval form and distant antennæ of the latter, and the enlarged thighs of the former. It contains but two species, one of which is the *B. rhois*, of Forster, a mottled reddish beetle, quarter of an inch long, found abundantly on the sumach. *Œdionychis*, Latr., contains many species, most of which do not vary much from a quarter of an inch in length. The most common style of coloration is that of a yellow thorax and dark metallic elytra, but some are brown or yellow with black stripes. In these, as in all the larger Halticini, the elytra are irregularly punctured, whilst in most of the small species they are punctured in rows. The generic name is expressive of the swollen claw-joint.

Hypolampsus, Clark, contains three N. A. species, the most common of which is the *H. pilosa*, of Illiger. *Graptodera*, Chevr., is composed of a number of dark blue species, one of which is the *Haltica (Graptodera) chalybea*, Illig., the destructive steel-blue flea-beetle of the grape vine. *Disonycha*, Chev., is scarcely distinguishable from Œdionychis except in the hind claw joint not being swollen. The species of the two genera, or more properly sub-genera, often closely resemble each other in size and color, but in Disonycha the style of coloration is most common which is exceptional in Œdionychis, namely, yellow with black stripes; but the most common species is black with a yellow thorax, on which are

[Fig. 86.]



HALTICA (GRAPTODERA) CHALYBEA, Illiger:—The Grape-vine flea-beetle; *a*, grape leaf eaten by young larvæ; *b*, larva, magnified; *c*, earthen cell, in which the insect transforms; *d*, beetle—after Riley.

three black dots arranged in a triangle; length a quarter of an inch; this is the *D. triangularis*, Say. Another species liable to be confounded with this is the *D. collaris*, Fab., but in this the thorax is yellow without spots, and the under side of the abdomen is dull yellow. *Orchestris*, Kirby, is the genus which contains the common cabbage and turnip flea-beetle, and its allies. They are about one-tenth of an inch long, black, with a broad waving yellow stripe along the middle of each wing-cover. Species closely resembling each other are equally abundant and destructive in Europe and in this country. The generic name means a *dancer* or *jumper*. *Longitarsus*, Latr., contains many small and closely allied species of a brownish color, and distinguished as the name implies by the greatly elongated first joint of the hind tarsi. *Systena*, Chev., is most readily distinguished by the elongate, narrow form of the species. The *Systena blanda*, Melsh., an eighth of an inch long, pale yellow with three darker stripes, has been found to be destructive to young corn, in the Middle States. The other genera in the table are composed of very small species, distinguished from the foregoing by having the elytra punctured in rows. *Dibolia*, Chev., contains but one known species, the *D. aerea*, Melsh., or brassy Dibolia, a tenth of an inch or a little more in length and of a brassy black color; found in the Middle and Southern States. The species of *Chætocnema*, Stephens, are found mostly in the Southern States and Texas. *Crepidodera*, Chev., contains many very small, usually black or reddish species; but one of the most common, the *C. helxines*, Linn., is sometimes purple and at others brassy green. This little species is said to be common to Europe and this country. The little Cucumber flea-beetle, *Haltica cucumeris*, of Harris, has been placed, in company with a few others, in a separate sub-genus *Epitrix*, Foudr., on account of their pubescent surface. But few species of the little genus *Psylliodes*, Latr., have been observed. Dr. Fitch refers to one of them, the *P. punctulata*, Melsh., as being somewhat injurious to the leaves of several kinds of garden vegetables. The generic name is de-

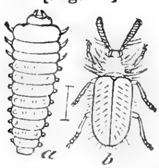
[Fig. 87.]

HALTICA CHALYBEA, Illiger: showing the swollen posterior thighs.

rived from a Greek word meaning a *flea*, in allusion to their power of leaping.

Sub-family HISPIDES.

[Fig. 88.]



HISPA:—*a*, larva; *b*, beetle—after Westwood.

This sub-family is founded upon the genus *Hispa*, of Linnæus, a contraction of the Latin word *hispida*, meaning *rough*, in allusion to the deep sculpturing of the elytra, which usually consists in a number of elevated ribs with a double series of deep punctures between them. The antennæ are short, straight, compact, closely approximate at base and regularly divergent at tip. These characters, together with their oblong and usually somewhat quadrate form, renders them one of the more easily recognizable groups in the whole order of Coleoptera. They are usually about a quarter of an inch in length or a little less, and their colors are black and red, either singly or combined. They seem to be a good deal confined to particular localities, and therefore are not very commonly met with. The larvæ are leaf-miners, feeding between the upper and lower laminæ. They differ in form from other Chrysomelide larvæ, and resemble more the larvæ of the Cerambycidæ, the head being much narrower than the body, and the three first segments being wider than the following ones. Their form and habits were first described by Dr. T. W. Harris, from species found upon the Oak, the Apple and the Locust.

The Hispides present two strongly marked genera: *Hispa*, moderately elongated and with strongly sculptured elytra, and *Stenispa*, much elongated and narrow, and with the elytra smooth and shining, and very faintly puncto-striate. The latter contains but two known species: the *metallica*, Fab., of a shining brassy black color, not quite a quarter of an inch long; and the *collaris*, of Baly, similar but having the thorax red. The former is widely distributed, and the latter inhabits the Indian Territory.

Hispa proper is limited to the small black European species, originally described by Linnæus, to which the term *hispid* is peculiarly appropriate, being beset with minute spines. The American species have been divided into two genera:

A. Antennæ 11-jointed; sculpture regular and distinct.................................. ODONTOTA.
A A. Antennæ 8-jointed; sculpture usually irregular or imperfect.................. MICRORHOPALA.

The regular sculpturing consists of deep punctures upon the thorax, and elevated ribs *(costæ)* upon the elytra, with a double row of numerous punctures between them. The species of *Odontota*, Chev., (same as *Anoplitis*, Kirby,) may be arranged according to their color, as follows. The length of each species is added in decimals of an inch; thus 0.24 expresses twenty-four hundredths of an inch.

Wholly black: *nigrita*, Oliv., 0.16.
Black varied with red:
Thorax red and elytra black: *bicolor*, Oliv., 0.25: *Ariadne*, Newm., 0.18: *Walshii*, Crotch, 0.14: *Lecontei*, Baly, 0.20.
Thorax red only at the sides, elytra black: *notata*, Oliv., 0.24.
Sides of thorax and shoulders of elytra red: *scapularis*, Oliv., 0.25: *omogera*, Crotch., 0.31.
Wholly or mostly red:
Wholly red: *rubra*, Weber, 0.20.
Red with a black suture: *Harrisii*, Crotch, 0.24.
Red usually with obscure brown or blackish spots: *quadrata*, Fab., 0.24: *rosea*, Web., 0.15.

Microrhopala, Chev., (meaning *a little club*,) is distinguished by having the antennæ apparently 8-jointed, the four last joints being consolidated, to which the generic name refers. The sculpture is usually either irregular or imperfect, as expressed in the following table of species:

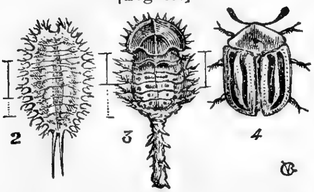
Ribs of elytra indistinct, and with fewer punctures.
Thorax and stripe on base of elytra red: *vittata*, Fab., and variety *lœtula*, Lec., 0.23.
Sides only of thorax and stripe on elytra red: *xerene*, Newm., 0.17.
Ribs more or less confounded with the few and large punctures:
Punctures moderate and somewhat regular, color blue: *cyanea*, Say, 0.23.
Punctures very large and confluent, color black: *excavata*, Oliv., 0.20.
Surface rugulose in all directions; black with front of thorax; scutellum and base of antennæ orange: *plicatula*, Fab., 0.20.
Ribs and punctures regular and distinct:
Color black: *porcata*, Melsh., 0.13.
Color red with obscure spots: *Melsheimeri*, Crotch, 0.13.

Most of these species are widely distributed east of the Mississippi river, but a few of them, (*nigrita*, *notata*, and *plicatula*) have as yet been observed only in the Southern States.

Sub-family CASSIDIDES.

This sub-family is founded upon the genus *Cassida* of Linnæus, a term derived apparently from the Latin *cassida—a helmet.* They are easily recognized by their rounded and usually more or less flattened form, the thorax and elytra being dilated into a broad thin margin, beneath which the head and limbs are retractile so as to be sometimes partially, but usually wholly concealed. In this respect some of them bear a close resemblance to some of the genera of scavenger beetles, such as Peltis, Thymalus and Nitidula, but from these they can be readily distinguished by their strongly dilated and deeply bilobed tarsi, and their antennæ not abruptly enlarged at the tip. They are of medium or rather large size, and are often prettily colored. A few species are extremely brilliant, resembling drops of burnished gold, but this brilliancy appears to be in some way dependent upon the vital functions, as it disappears immediately after death. The larvæ are oval, flattened, prickly grubs, feeding upon the surface of leaves, often in company with the perfect insects. Many of the foreign species feed upon thistles

[Fig. 89.]



CASSIDA BIVITTATA, Say:—2, larva; 3, pupa; 4, beetle—after Riley.

and other plants of the composite family, but most of the American species are found on different species of convolvulus, especially the morning-glory and the sweet-potatoe, both of which belong to this genus of plants. The leaves of these plants are often riddled with holes, and seriously injured by these insects.

It is in this family that the habit of the larvæ of covering themselves with their own excrement is most conspicuous and universal. Other larvæ (*Crioceris* and *Blepharida*), which have this habit, void their excrement directly upon their backs, but the larvæ of Cassida support their excrement on a long forked process which issues from the body just above the anal aperture, and is directed forwards over the body like a parasol. The object of this singular habit is supposed to be to protect the insects either from birds and other natural enemies, or from the direct rays of the sun. The former is probably the true explanation. That it can not be the latter, seems to be proved by the practice of most of these larvæ of feeding upon the under side of the leaves where the direct rays of the sun cannot reach them. Mr. Riley has stated this to be the habit of the larvæ of many of the Cassidides, and I have observed the same to be true of the larvæ of Blepharida rhois.

The Cassidides present four well marked genera as follows:

A. Head prominent, visible; size below medium; color blue .... PORPHYRASPIS.
A A. Head partially visible; prosternum advanced; size large; red spotted with black.. CHELYMORPHA.
A A A. Head completely concealed.
B. Body oblong oval, convex; size large; color dull greenish brown.................. PHYSONOTA.
B B. Body oval or orbicular, moderately convex or depressed; size about medium; colors various .... CASSIDA.

Porphyraspis, Boheman, meaning a *purple shield*, is founded upon the *Cassida cyanea* of Say, found in the Southern States. *Chelymorpha*, Chev., signifies literally *tortoise shape*. It has for its type the *C. cassidea*, Fabr., subsequently named *cribraria*, by the same author. It is also the *C. argus* of Herbst. It is about four-tenths of an inch long, of an oblong oval, convex form, brick-red, with four or six black dots on the thorax, and six on each elytron. The larva is said to feed upon the milkweed. *Physonota*, Boh., meaning *swollen* or *convex back*, contains the *P. unipunctata*, Say, of about the same form and size as the preceding species, but the head is completely hidden under the anterior margin of the thorax. It is of a dull greenish or yellowish-brown color, with one, three, or five black dots on the thorax. *Cassida* has been divided into two sub-genera, *Cassida* proper having the antennæ not longer than the thorax, and usually of a sub-convex, oval form; and *Coptocycla*, with the antennæ longer than the thorax, and usually of an orbicular and depressed form. The species which occur in this section of country may be tabulated as follows:

Cassida proper.

nigripes, Oliv.; length one-fourth inch or less; dull red, with three obscure black dots on each elytron, in a triangle; puncto-striate. The *pallida*, Herbst, is probably a pale variety of this.

bivittata, Say; length two-tenth inch; thorax dull red; elytra yellow, with a black suture and two black stripes on each; puncto-striate.

thoracica, Boh.; length three-tenth inch; pale green, region of the scutellum obscure brownish; irregularly punctate.

Coptocycla.

aurichalcea, Fab.; length less than one-fourth inch; golden yellow, pale yellow after death, puncto-striate.

clavata, Fab.; length more than one-fourth inch; uneven, dark brown; margin of thorax and middle and tip of margin of elytra, pale transparent.

guttata, Oliv.; length less than one-fourth inch; varying from pale brown to blackish brown, sometimes spotted with yellow; the whole margin, except the shoulders of elytra, pale transparent.

purpurata, Boh.; less than one-fourth inch; brownish red with a lateral triangular transparent patch; rare.

Section IV. *TRIMERA.*

Apparently three joints in all the tarsi, except the Erotylidæ, which have four or five; the joints dilated and brush-like beneath, with the penultimate usually bilobed.

This, like the other primary sections of the Coleoptera, is based upon the apparent number of joints in the tarsi. We have stated in the introductory part of this treatise that the highest, and what may therefore be called the normal or typical number of joints in the feet of the Coleoptera, is five, and that whenever there appears to be a lesser number the rudiments of the deficient joints, or a part of them, can usually be detected by close inspection. The present, or *trimerous* section, is less perfect or more exceptional in proportion to the number of the species, than any of the preceding sections, that is to say, a considerable number of genera and species which require to be associated with the trimerous beetles in consideration of their general structure, have four distinct joints in their tarsi, besides the indistinct rudiment of the missing and penultimate joint.

The antennæ are almost always clubbed at the end and the tarsi are dilated, bilobed, and with a brush of hairs on the under side. The first of these characters allies them to the club-horned scavengers and distinguishes them from the Chrysomelidæ, whilst the latter character allies them to the last named family and at the same time distinguishes them from the Clavicornes proper. The great majority of them are remarkable for the very wide terminal joint of the maxillary palpi. They are almost always of small or moderate size.

This section is much smaller than the others, and contains but two tribes, which bear but little resemblance to each other in form, and are wholly unlike in their habits.

Tribe 1st (or 20th). Trimerous fungus-beetles. *Trimera fungivora.* BOLITOPHAGA.

Body oval or oblong; antennæ exposed and often nearly or quite as long as the head and thorax; colors red and black, usually combined; habits fungivorous. Families: Erotylidæ, Endomychidæ.

Tribe 2d (or 21st). Plant-louse eating beetles. *Trimera carnivora.* APHIDIPHAGA, Latreille.

Body hemispherical; antennæ very short and usually concealed beneath the margin of the thorax; elytra usually red with black dots, sometimes the reverse; feed upon plant-lice. Family: Coccinellidæ.

TRIBE XX.

TRIMEROUS FUNGUS-BEETLES.

Trimera fungivora. BOLITOPHAGA.

This is a tribe of moderate extent, and is composed of the families Erotylidæ and Endomychidæ. The former were designated by Latreille by the name *Clavipalpi*, on account of the large half-moon shaped joint with which the maxillary palpi are usually terminated, and were placed by him in the tetramerous section in deference to the tarsal system of classification, inasmuch as four distinct joints are usually present in the tarsi, besides the rudimental penultimate joint. But their general resemblance to the Endomychidæ in size, color and habits, as well as in several important organic characters, has induced all recent systematists to place the two families in the same general division. It is a much more difficult question to decide whether these insects should be retained as a distinct tribe near the end of the order, between the Chrysomelidæ and the Coccinellidæ, or be merged in the extensive series of club-horned scavengers, or Clavicornes proper, with which they agree in their clavate antennæ, and also with some of them in their fungivorous habits. Mr. Westwood, whilst he retains them in the former position, expresses a doubt whether they should not be placed in the necrophagous or scavenger series, as Mr. Stephens previously, and Mr. Thomson more recently has done; and Mr. Crotch, in his recent revision of these families, expresses the opinion that the Erotylidæ should immediately follow Cryptophagidæ, and that the Endomychidæ should succeed the Mycetophagidæ. Other authors, whilst leaving the families in general undisturbed, have contented themselves with removing from them certain genera, which are usually associated with them; Mr. MacLeay, for example, having removed Languria to the family of Engidæ, corresponding nearly to our two families of Trogositidæ and Cucujidæ, whilst Mr. Stephens has placed Tritoma in the family of Anisotomidæ. If the number of joints in the tarsi were the only character which distinguishes

these tribes, their separation, probably, would never have taken place, since, as we have seen, the number of these joints is subject to much variation in the smaller species of Clavicornes. But a much more important distinctive character is the structure of the tarsal joints; being dilated, evenly cushioned beneath, and with the penultimate joint often deeply bilobed, thus allying them to the Phytophaga, whilst it separates them from the pentamerous Clavicornes, which, though they usually have the tarsi more or less garnished with hairs, never, we believe, exhibit the dense and even brush of hair-like papillæ which is so characteristic of the genuine Tetramera; and in the few instances in which any dilatation of the tarsi occurs among the Clavicornes, it is small in extent and limited to the anterior feet of the males, being a sexual distinction. It is also worthy of note that the important and rudimental joints in the present tribe are uniformly the penultimate, as in the tetramerous section, whilst in the imperfectly developed tarsi of the small pentamera, it is usually the first, or first and second joints that are deficient.

The characters of the few known larvæ of this tribe do not afford any clear indications of their systematic position; for whilst the larva first described by Fischer and copied by Westwood, and supposed to be that of Tritoma, strikingly resembles the larvæ of the Chrysomelidæ in its thick fleshy and spotted body, the larva of Triplax, figured by the last named author, bears, as he remarks, a strong resemblance to that of the genus Colydium, which we have placed in our aberrant group of *Subclavicornes;* and the larvæ of Endomychus have been compared both to those of Silpha and Lampyris. Thus it appears that the position of these families, separate and remote from the pentamerous Clavicornes, first assigned to them by Latreille, rests upon strong considerations; and we may add that Lacordaire, one of the latest and highest authorities upon the classification of this order, has virtually given his sanction to this arrangement. For though his work had not reached the trimerous section, at the time of his death, it is evident, from his not including them in the pentamerous series, that he had reserved them for this position.

It is worthy of remark that the dilated and cushioned tarsi of these insects would seem to indicate a decided diversity of habit as compared with other fungus beetles which have simple tarsi. The most obvious explanation is that this structure of the feet enables them to adhere to the smooth surface of the boleti upon which they deposit their eggs and in which their larvæ reside, whilst those beetles which subsist mostly upon the fungi which grow beneath the bark of decaying trees, require no such provision.

The following table gives the principal distinctive characters of the two families of this tribe:

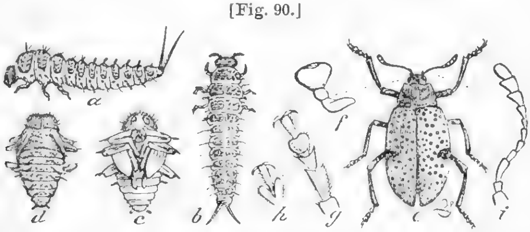
A. Tarsi apparently 4-jointed, sometimes 5-jointed; antennæ usually shorter than the head and thorax, and with a club of from three to six joints; maxillary palpi usually terminated by a wide securiform joint. Thorax convex: EROTYLIDÆ.

A A. Tarsi apparently 3-jointed, sometimes 4-jointed. Antennæ usually as long as the head and thorax, or longer, with the two or three terminal joints slightly enlarged; maxillary palpi nearly cylindrical, labials sometimes enlarged at the end. Thorax usually with three depressions at the base, and with a wide lateral margin.................................ENDOMYCHIDÆ.

Family LXII. EROTYLIDÆ.

This is a family of moderate extent founded upon the genus *Erotylus*, of Fabricius, a term borrowed directly from the Greek, and meaning *friendly* or *pleasing*—probably in allusion to the contrasted colors of many of the species. They are of moderate or small size, only a few species of Dacne and Erotylus proper attaining to half an inch in length, whilst the great majority are less than a quarter. The most common coloration is a red thorax with black, or black and red elytra, or the reverse; but some species are unicolorous.

[Fig. 90.]



CYPHEROTYLUS BOISDUVALI, Chev.:—*a*, *b*, larva, side and back views; *c*, *d*, pupa, under and upper sides; *e*, beetle, natural size; *i*, antenna; *j*, palpus; *g*, tarsus from below; *h*, terminal joint of same from above—after Riley.

The leading characters have been given in the preceding table and in the general description of the tribe. We will only repeat here that the two principal characters by which they are distinguished from other fungus-eating beetles are their widened tarsi, covered beneath with a dense brush of hair-like papillæ, with the last joint but one usually bilobed, and the form of the terminal joint of the maxillary palpi—which with a few exceptions is broadly triangular, whilst the pentamerous and heteromerous fungivorous beetles have slender tarsi, at most loosely haired on the under side, and the palpi of the same width throughout, or, in some of the Diaperidæ, a little widened at the end. These insects usually inhabit the fungi which grow upon trees, but we have found several species of Languria upon flowers, especially the umbellifera.

A. Body elongate and parallel; club of antennæ 5 or 6-jointed; tarsi 4-jointed; palpi not dilated; eyes finely granulated...LANGURIA.
A A. Body oval; club of antennæ 3-jointed, rarely 4-jointed.
B. Tarsi 5 jointed; palpi not dilated; form oblong oval.......................................DACNE.
B B. Tarsi 4-jointed; 3d joint of maxillary palpi strongly dilated; form oval or short oval.
C. Eyes large and coarsely granulated...ISCHYRUS.
C C. Eyes moderate, finely granulated; size small...TRIPLAX.

Languria, Latr., contains about a dozen N. A. species. The most common is the *L. bicolor*, Fab., upwards of a third of an inch in length, blue-black except the thorax, which is dull-red with a black spot on the middle. The *L. Mozardi*, Latr., is similar but smaller; the elytra have a greenish tint, the antennæ and thighs are reddish at base, and the thorax is without the black spot on the disk. *Dacne*, Latr., contains five species of very unequal size. The name is derived from the Greek *dakno—to corrode.* The *Dacne heros*, of Say, is two-thirds of an inch in length or upwards, black with two broad, dull-red bands across the elytra. The *D. fasciata*, Fab., is similar, but only about half an inch long, and the bands are of a lighter and brighter color. The *D.* 4-*maculata*, Say, is only about one-tenth of an inch long, black, with two red spots on each elytron. *Ischyrus*, Lacord.,—a term meaning *robust*—contains three species, the largest of which, the *I.* 4-*punctatus*, Oliv., is not uncommon. It is about a third of an inch long, light orange-red varied with black, and with a transverse series of four black dots on the thorax.

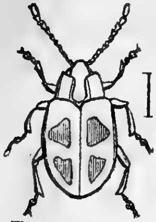
The genus *Triplax*, of Paykull,—a term meaning *three-fold*, in allusion probably to the three-jointed club of the antennæ—is much more numerous in species than the others. Mr. Crotch enumerates eighteen species, a part of which he has placed separately under the generic term *Cyrtotriplax*—the prefix meaning *convex*—on account of their short ovate form, and the body not strongly punctured beneath. This distinction had already been made by Fabricius, who gave to those short convex species the name *Tritoma*, which seems to have been abandoned on account of its confused synonomy. The species of Triplax are all small, being between one-eighth and two-tenths of an inch in length, and variegated with black and red. *Cypherotylus*, Cr., contains a single large and striking species, the *Boisduvali*, Chev. (Fig. 90), tolerably common in the Rocky mountain region of Colorado, where Mr. Riley has found its larva feeding on tree-fungi.

Some of the species indicated are closely allied and are perhaps only varieties.

Family LXIII. ENDOMYCHIDÆ.

This is a family of small extent, named from the genus *Endomychus*, Paykull, a name derived from the Greek *endon—within*; and *muchos*—a *concealed place*—probably referring to the concealed habitations of these

[Fig. 91.]



ENDOMYCHUS:—After Rye.

[Fig. 92.]

Maxillary palpus of ENDOMYCHUS.

insects and their larvæ in the substance of boteli or tree-fungi. The most remarkable character of this family, as compared with the Coleoptera in general, is the diminution in the number of the joints of the tarsi, but three joints being visible even in species of considerable size, with a scarcely perceptible rudiment of another joint at the base of the last; all the joints except the last being dilated and cushioned beneath, and the second joint deeply bilobed. The antennæ are usually longer than the head and thorax combined, and with the two or three last joints slightly enlarged. The thorax is almost square, and in most of the genera has a wide thin margin, which is slightly turned upwards at the sides.

A. Tarsi 3-jointed. Length from one to two-sixths of an inch.
  B. Palpi clavate, thorax a little wider behind; antennal club of three equal joints...ENDOMYCHUS.
  B B. Palpi cylindrical; thorax a little narrower behind; antennal club indistinct, the last joint somewhat dilated and compressed........LYCOPERDINA.
A A. Tarsi 4 or 5-jointed. Length less than one-sixth of an inch.
  C. Thorax about square; tarsi 4-jointed.
    D. Anterior coxæ contiguous........RHANIS.
    D D. Coxæ separated by the prosternum; antennal club enormously dilated in the males: PHYMAPHORA
  C C. Thorax wider than long; size very small.
    E. Antennæ 11-jointed; form oval; body hairy........MYCETÆA.
    E E. Antennæ 10-jointed; form globose; tarsi 5-jointed........ALEXIA.

Endomychus proper contains but one N. A. species which closely resembles the *E. coccineus* of Europe. It is the *E. biguttatus*, Say—one-sixth of an inch long, black, with the elytra bright-red, with two black spots on each, the larger one near the tip. *Lycoperdina*, Latr., derived from *Lycoperdon*, a genus of fungi—contains many species which have been divided into several genera, or sub-genera, by more recent authors. The most common species is the *L. vitatta*, Fab., (or *lineata*, Olivier;) a quarter of an inch long, with three broad stripes on the elytra, the middle one being common to both. The *L. ferruginea*, LeC., is a little smaller, of a piceous or reddish-black color, with the head, legs and margins of the thorax and elytra brownish-red. The other genera contain but one or two species each. The two last genera are anomalous, and do not strictly belong in this family.

TRIBE XXI.

PLANT-LOUSE BEETLES.

Trimera carnivora. APHIDIPAGA, Latreille.

The rounded or hemispherical form of these insects, commonly known by the name of lady-birds, and their dotted coloration, render them one of the most easily recognized of all the families of Coleoptera. Their

three-jointed tarsi, and the broad hatchet-shaped terminal joint of the maxillary palpi, are their most distinctive organic characters. The tarsal joints are always dilated and cushioned beneath, and the second joint is deeply bilobed.

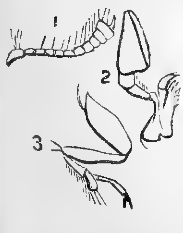
These insects seem to be specially appropriated to keeping in check the extensive families of plant-lice, both the leaf-lice (*Aphides*), and the bark-lice (*Coccides*), upon which they feed voraciously, in both the imago and the larva states; and they are also known to devour the eggs of other insects. Mr. Westwood refers to some observations which go to show that they must sometimes subsist upon vegetable food, and I have seen the *Coccinella* 15-*punctata*, Oliv., with its head deeply immersed in a ripe raspberry, implying that they sometimes feed upon the juices of ripe and succulent fruits; but such cases are rare and exceptional to their general habits. It is not uncommon to find branches of trees thickly covered with the scales of bark-lice, almost every one of which has been torn open and its occupant destroyed by these predaceous insects.

The larvæ are oblong, blackish grubs, and are usually thickly beset with spines, which are also furnished with smaller spines or prickles, giving them, when magnified, a formidable appearance. These, as is the case with other larvæ, are much more voracious than the perfect insects. When about to pupate they suspend themselves by the tail to a leaf or branch, and either push the larval skin upwards, where it remains shrivelled about the point of attachment, or remain within it till they emerge in the beetle form, when it bursts open upon the back and permits the enclosed insect to escape. This tribe of beetles is composed of the single family of Coccinellidæ.

Family LXIV. COCCINELLIDÆ.

As this family is co-extensive with the tribe to which it belongs, we have only, in treating of it, to refer back to the remarks already made. In a systematic point of view the Coccinellidæ occupy a remarkably anomalous and isolated position, in consequence of the apparent heterogeneousness of their organic characters. Whilst having the rounded form of the plant-beetles, the clavate antennæ of the scavengers, and the dilated palpi of the fungus-beetles, they agree in food and habits with none of these, but resemble, in their predaceous habits, the pentamerous ground-beetles, and the soft-winged carnivora, all of which have their bodies more or less elongated, their antennæ filiform, and their palpi slender or but moderately dilated. Moreover, the reduction in the number of their tarsal

[Fig. 93.]



COCCINELLA:—1, antennæ; 2, maxillary palpus; 3, tarsus—after Westwood.

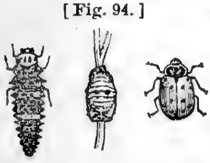
joints evidently places them at the extreme end of the order, whilst their predaceous habits ally them to the pentamerous carnivora which occupy the first rank in the perfection of their organization.

The name Coccinella is derived from the Coccus which produces the cochineal dye, and was suggested by the prevalence of bright red in the coloration of these insects.

A. Antennæ nearly as long as the head and thorax; elytra almost always red dotted with black; length more than a sixth of an inch.
B. Body somewhat oblong; anterior margin of the thorax nearly or quite straight....HIPPODAMIA.
B B. Body hemispherical; anterior margin of the thorax more or less concave.........COCCINELLA.
A A. Antennæ usually very short; elytra never red; length almost always less than a sixth of an inch.
C. Thorax deeply hollowed in front so as to embrace the head; color black, usually dotted or varied with red or white.
D. Surface glabrous; black, dotted with red, or whitish.
E. Margin of elytra wide and entire; size various.................................CHILOCORUS.
E E. Margin of elytra narrow and pitted, for the reception of the tips of the thighs; size small...HYPERASPIS.
D D. Surface pubescent; black, sometimes varied or tipt with red......................SCYMNUS.
C C. Anterior margin of thorax nearly straight.
F. Margin of elytra entire; prosternum not advanced; color white with black dots: PSYLLOBORA.
F F. Margin of elytra pitted; prosternum advanced so as to conceal the mouth; color black without spots; size minute..ŒNEIS.

Hippodamia, Chev., has for its type the *H. maculata*, of DeGeer, the most common of all our Coccinellidæ; nearly a quarter of an inch in length; scarlet-red with six large black dots on each elytron, two of which join those on the other elytron at the suture. About fifteen other species have been indicated, most of which exhibit a tendency to follow this type of coloration. Upwards of twenty N. A. species of *Coccinella*, Linn., have been described and distributed in a number of sub-genera, founded for the most part upon obscure or unimportant characters. *Chilocorus*, Leach, contains the common *C. bivulnerus*, Muls., two-tenths of an inch long, black, with a red dot on the middle of each wing-cover, so useful in destroying the bark-lice of the apple tree, and of the pine leaf. The *C.* (*Exochomus*, Redt.) *tripustulatus*, DeG., is similar but larger, with a red spot on each shoulder, and a spot on the suture behind the middle. *Hyperaspis*, Redt., meaning literally *covered by a shield*, contains many species readily distinguished by their small size and their black color, dotted with red, or whitish. *Brachyacantha*, Muls., differs from Hyperaspis only in the presence of a minute spine on the outer margin of the anterior tibiæ.*

[Fig. 94.]



HIPPODAMIA CONVERGENS: —Larva, pupa and beetle—after Riley.

* The separation of *Megilla* and *Ceratomegilla* from *Hippodamia*; of *Mysia* and *Cycloneda* from *Coccinella*; of *Exochomus* from *Chilochorus*; and of *Brachyacantha* from *Hyperaspis*, under distinct generic names, are examples of the modern tendency to the excessive multiplication of genera, often founded upon the most trivial characters.

Scymnus, Herbst, contains a considerable number of very small black species, easily recognized by their downy surface, and the usually tawny tips of the elytra, or margins of the thorax, characters which appear to have suggested the generic name, which literally means a *young lion;* a name, however, which had already been given by Cuvier to a genus of fishes of the shark family. *Pysllobora*, Chev., contains the *P. 20-maculata*, Say, a little species a tenth of an inch or less in length, readily distinguished from all our other Coccinellidæ by its white color densely sprinkled with black dots. Two other and similar species have been described, which perhaps are only varieties. *Œneis*, Mulsant, is represented by the minute *Œ. pusilla*, LeC., only a fifteenth of an inch in length, almost globular in form, and of a shining black color. The male has the head, sides of thorax and legs yellow.

CATALOGUE OF THE PRINCIPAL AUTHORS

Who have written upon the Coleoptera, with special reference to the describers of N. American species, or of their Natural History, and with the ordinary abbreviations of their names prefixed.

Aub. Dr. Charles Aube, a French entomologist; author of a general work upon the water-beetles, and of a Monograph of the Pselaphidæ, 1834, and a Revision of the same, 1844.

Aud. Jean Victor Audouin, M. D., Librarian to the Institute of France, and one of the Curators of the Jardin du Roi. An eminent French naturalist and comparative anatomist. Author of many works from 1818 to 1830. Some of his most valuable writings are his Memoires upon the anatomy and physiology of Insects and other Articulata.

Beauv. or Pal de B. Palisot, Baron de Beauvois, a French entomologist. Author of a descriptive work upon insects collected in Africa and in America—1805 and subsequently.

Blanch. Emile Blanchard, author of a Catalogue of the Entomological Collection in the Museum of Nat. History of Paris, 1850, and of a large illustrated work upon the Metamorphoses of Insects.

Bland. James H. B. Bland, describer of a number of N. A. Coleoptera in the Proceedings of the Ent. Soc. of Philadelphia.

Boh. C. H. Boheman, author of a Monograph of the Cassididæ—1850-62—and descriptions of New Species of Coleoptera. N. Mem., Natur., Moscow.

Bon. Francisco Bonelli, professor of Zoology at Turin. An Italian Naturalist. His principal entomological work was a Memoir upon the Carabidæ. 1811.

Brend. Emil Brendel, M. D., of Peoria, Illinois. Author of several papers upon the Pselaphidæ, with descriptions of new species, in the Proceedings of the Ent. Soc. of Philadelphia, 1865-66.

Burm. H. Burmeister, a learned German entomologist. His principal work is the Handbook of Entomology, in 6 vols., 8-vo, 1832-47. The elementary part of this work has been translated into English by W. E. Shukard, 1 vol., 8-vo, 654 pages, London, 1836.

Chaud. Baron M. de Chaudoir, a Russian entomologist. Author of several memoirs upon the Caribidæ, in which a number of N. American species are described. 1842-7.

Chev. A. Chevrolat, a French entomologist. Author of the Coleoptera of Mexico, and other writings upon the insects of this order.

Crotch, G. R., Cambridge. Mass. Author of Synopsis of the Dytiscidæ, Chrysomelidæ, Erotylidæ, Endomychidæ and Coccinellidæ of the U. S., published in the Proc. Acad. Nat. Sciences, of Philadelphia, and in the Trans. Am. Ent. Society, 1873; and of a Check List of N A. Coleoptera, 1874.

Dalm. John Wm. Dalman, director of the museum at Stockholm. Author of various works upon different orders of insects. 1823-6.

Deg. Baron Charles DeGeer, marshal of the Court of the Queen of Sweden, born 1720, died 1778. Author of a History of Insects, in 7 vols., 4-to, with plates, 1752-78. A work replete with accurate details of the habits of insects, and forming a fit sequel to the similar work of Reaumur, the last volume of which was published ten years before the work of DeGeer was commenced.

Dej. Count Dejean, peer of France and lieut.-general in the French army. Author of a catalogue of the Coleoptera in his own extensive collection; and of a general descriptive work in several volumes, from 1825 to 1831, which contains descriptions of many N. American species.

Drur. Drury, an English goldsmith. Author of a finely illustrated work, in 3 vols., 4-to, containing upwards of six hundred and fifty colored figures of the rarer insects in his own cabinet, amongst which are many American species. 1770-82. Enlarged by Mr. Westwood in 1837.

DUF. Leon Dufour, a French physician and comparative anatomist. One of the principal authorities upon the internal structure of insects.

DUM. Constant Dumeril, professor to the Faculty of Medicine and to the Jardin du Roi. An eminent French naturalist and comparative anatomist; born at Amiens, 1774. Author of many works in different departments of natural history, among which was a work entitled General Considerations upon the Class of Insects. His works date from 1806 to 1830.

ER. or ERICHS. William F. Erichson, of Berlin, in Prussia, lately deceased, one of the ablest writers of recent times upon the Coleoptera. His works are written in the German language. There is another author of the same name, G. F. Erichson, also of Berlin, author of the genera and species of the Staphylinidæ.

ESCH. Friedrich Eschscholtz, a Prussian entomologist. Author of a zoological atlas, 1829, and a work entitled Entomographien, in the German language.

FAB. or FABR. John Christian Fabricius, professor of natural history at Kiel, in Denmark. A pupil of Linnæus, and one of the most eminent and voluminous writers upon insects; born 1742, died 1807. Author of many works, and the original describer of a large proportion of the American insects known at that time.

FISCH. Gotthelf Fischer de Waldheim, director of the imperial museum at Moscow, Russia. Author of numerous works, from 1801 to 1824. His principal work was the Entomography of the Russian Empire, in 2 vols., 4-to, with splendid engravings. 1820-22.

FITCH. Asa Fitch, M. D., entomologist to the Agricultural Society of New York. Author of thirteen annual reports upon insects of New York, chiefly those injurious to agriculture. First report published in 1856. Dr. Fitch's writings have contributed greatly to the dissemination of useful information upon the injurious insects of the United States.

FORST. Dr. John Reinhold Forster. Author of a description of a Hundred New Species of Insects, London, 1771, among which were a few N. American Coleoptera.

GEOFF. M. Geoffroy, a celebrated French physician and entomologist. Author of an Abridged History of Insects, 2 vols., 8-vo, with plates, 1764, and of a Description of the Insects in the Environs of Paris. Many genera of Coleoptera were first defined in these works.

GLOVER. Townend Glover, entomologist to the Department of Agriculture, at Washington. Author of numerous brief monthly reports upon injurious insects, and of an extensive series of plates, illustrative of North American insects in all the orders, but of which only those appertaining to the Orthoptera have yet been published.

GM. or GERM. E. Francis Germar, professor of mineralogy at Halle, in Prussian Saxony. Editor of the "Magazin der Entomologie," 4 vols., 8-vo. 1813-21, and of the "Insectorum Species Novæ," 1 vol., 1824—an accurate describer of many genera and species of Coleoptera.

GRAV. J. L. C Gravenhorst, a German entomologist. Author of a Monograph of the Staphylinidæ, 1806, and of a Nosology of the genus Ichneumon, 1814—a standard authority upon these two families of insects.

GUER. M. Guerin-Meneville, a distinguished French entomologist. Author of Species and Genera of the Articulated Animals, 1843 and subsequently; and editor of the Magazine of Zoology, and of the Zoological Review.

GYLL. L. Gyllenhal, a Swedish naturalist. An original describer of some of the genera which contain American species. Author of "Insecta Suecica," 1827.

HALD. S. S. Haldeman, an American naturalist. Author of a large number of memoirs in various branches of natural history, and original describer of many N. American Coleoptera, mostly between the years 1842 and 1852.

HARR. Thaddeus Wm. Harris, M. D., librarian of Harvard University, in Cambridge, Massachusetts, a distinguished American entomologist. Author of a Treatise on Insects injurious to Vegetation, 1st edition 1852, 2nd ed. 1862, and author of many other valuable contributions to American entomology; born 1795, died 1856. It is a matter of lasting regret that the exacting requirements of his office of librarian prevented Dr. Harris from giving to the world, in a connected and systematic form, the results of his long and enthusiastic study of insects in all their orders.

HENTZ. N. M. Hentz, professor at Chapel Hill University, North Carolina. Author of a Monograph of the Spiders of the United States, published in the 21st volume of the American Journal of Science, 1833, and describer of a number of N. American Coleoptera.

HBST. J. F. W. Herbst, originally a preacher at Berlin, Prussia, born 1743. A voluminous writer upon insects. One work, in 10 volumes, was devoted wholly to the Coleoptera, 1785 to 1806. Another of his works is a Monograph of the genus Papilio. All his works were illustrated by colored plates.

HOFFGG. Count Hoffmansegg, a learned naturalist of Saxony, and a zealous patron of the sciences. Author of various memoirs in Illiger's Magazine and elsewhere.

HOPE. Rev. F. W. Hope, an English entomologist, possessor of a fine cabinet of insects. Author of the Coleopterist's Manual, 1837. Most of his original descriptions are in the family of Lamellicorn beetles.

HORN. George H. Horn, M. D., of Philadelphia. Author of a Revision of the Tenebrionidæ of America, north of Mexico, 1870, and of Synopses of the Histeridæ and Bruchidæ of the U. S., 1873, and other memoirs upon N. American Coleoptera.

ILLIG. I. C. G. Illiger, professor at Berlin, an eminent naturalist, second only to Linnæus in the felicity and elegance of his nomenclature. Though he died in middle life, his works extended to 13 vols., 8-vo, embracing all departments of natural history. His most extensive work is his Magazine of Entomology, in 7 vols., 8-vo, 1801-1807

KIRB. Rev. Wm. Kirby, rector of Barham, England, an eminent English entomologist. Author of various works upon different orders of insects. His most important work was an Introduction to Entomology, in 4 vols., 8-vo., by Wm. Kirby and Wm. Spence, 1st edition in 1815. This was for many years the principal elementary work upon insects in the English language. Mr. Kirby was also author of that part of the Fauna Boreali-Americana which treats of insects, 1 vol., 4-to, 1837, in which many N. American insects, chiefly Coleoptera, are described.

KNOCH. A. G. Knoch, a German entomologist. Author of the Neue Beitræge zur Insectenkunde, 1 vol., 8-vo, 1801.

LACORD. Theodore Lacordaire, professor of zoology and comparative anatomy in the University of Liege, and chevalier of the Order of Leopold. A very eminent French naturalist and entomologist, recently deceased. His works extend over a period of upwards of forty years, among which was an Introduction to Entomology, published as a part of the Suites a Buffon, 2 vols., 8-vo, 1834-38. But the crowning work of his life was the Genera des Coleoptères, in 10 vols., 8-vo, the last volume of which was not completed at the time of the author's death, on the 18th of July, 1870.

LAF. M. de LaFerte-Senecterre, a French entomologist. Author of an elaborate monograph of Anthicus and allied genera, 1848.

LAP. F. L. de Laporte, a French entomologist. Author of Etudes Entomologiques, 1835, and other works; original describer of a number of genera and species of N. A. Coleoptera.

LAT. or LATR. Pierre Andre Latreille, professor of the museum of natural history, in Paris; born at Brives, France, in 1762. A very eminent French naturalist, sometimes styled the prince of entomologists. The genius of this celebrated author illuminated every department of the science of entomology, embracing all the classes of articulated animals. His labors extended through a period of about thirty years. The first of his numerous publications bears the date of 1800. His three principal works are: a Natural History of Crustacea and Insects, 6 vols., 8-vo, 1802-5; Genera of Crustacea and Insects, 4 vols., 8-vo, 1806-7; and the department of Crustacea, Arachnida and Insects, in Cuvier's Animal Kingdom, 2d edit., 1828.

LEACH. W. E. Leach, an English physician and naturalist, one of the curators of the British museum. Author of numerous memoirs upon all the classes of the Articulata, and editor of the Zoological Miscellany, 3 vols., 8-vo, 1817.

LEC. John L. LeConte, M. D., of Philadelphia—the principal American authority upon North-American Coleoptera. Author of a classification of the Coleoptera of North America, 1 vol. 8vo. 1861–1873; and of many articles upon the different families of Coleoptera, from 1844 to the present time; and original describer of a large proportion of the North American species in this order of insects. Dr. LeConte's father, Major John LeConte, was also a zealous entomologist, joint author with Boisduval of a General History of North American Lepidoptera and their Caterpillars, of which but one volume was published, in Paris, 1833; and author of a monograph of North American Histeridæ, in the Boston Journal of Natural History, 1845.

LINN. Charles de Linne, usually written in the Latinized form of Linnæus. Professor of Natural History at Upsal, in Sweden. Born in 1707, died 1778. One of the most eminent of naturalists, and founder of the modern system of nomenclature, both in Natural History and Botany. His name is stamped upon almost every page in the nomenclature of plants and of every department of animated nature. He was the author of nineteen distinct works, the principal of which were the "Species Plantarum," and the "Systema Naturæ." First edition 1735; 13th edit. 7 vols 8vo. 1788.

MACL. W. S. MacLeay, an English entomologist, a learned and philosophical writer upon insects and their classification. Author of the Horæ Entomologicæ, 1 vol. 8vo. 1819, and other works.

MANN. C. G. Mannerheim, Counsellor to the Emperor of Russia. Author of a monograph of the Euconemidæ, 1823, and of a New Classification of the Staphylinidæ, 1830, and of several memoirs in the Bulletin of the Imperial Society of Naturalists of Moscow, in which species from Sitka and California are described, 1843–46.

MARS. S. A. de Marseul, a French Entomologist. Author of an elaborate monograph of the Histeridæ, 1853–1860; and of a catalogue of the Coleoptera of Europe, 1866.

MELSH. Friedrich Ernst Melsheimer, M. D., a zealous contributor to American Entomology; died recently at Davidsburg, in Pennsylvania, March 10, 1873, at the advanced age of nearly ninety-one years. Author of the first general catalogue of Coleoptera published in the United States, 1806, which was revised and enlarged by LeConte and Haldeman in 1853. Also, author of many papers in the 2d and 3d volumes of the Proceedings of the Acad. of Nat. Sciences of Philadelphia, in which upwards of four hundred and fifty species of N. A. Coleoptera were first described. His father, Rev. E. F. Melsheimer, was also an enthusiastic entomologist and a co-laborer with Thomas Say, the founder of descriptive entomology in the U. S.

MOTS. Victor de Motschulsky, a Russian entomologist. Author of Etudes Entomologiques, 2 vols. 8vo. 1853-61; and of a work on the Coleoptera of Siberia.

MULS. E. Mulsant, a French entomologist. Author of a monograph of the Coccinellidæ, 1850, and other works.

NEWM. Edward Newman, an English entomologist. Author of a Grammar of Entomology, 1835; and of an Illustrated Natural History of British Moths, 1869, and editor of the Entomological Magazine, in which a considerable number of American Coleoptera are described.

OLIV. Antoine G. Olivier, Professor of Zoology to the Veterinary School of Alfort, in France, born 1756, died 1814, a distinguished French naturalist Author of a Natural History of Insects, 5 vols. folio with colored plates, confined to the Coleoptera, 1789-1808; also of the department of insects in the Encyclopedie Methodique, 5 volumes, and other works; the original describer of many North American Coleoptera.

PACK. A. S. Packard, Jr., M. D., of Salem, Massachusetts. Author of a Guide to the Study of Insects. 1 vol. 8vo. 715 pages. 1st edition 1869, 3d ed. 1873; and author of various papers upon North American insects in the different orders.

PANZ. G. W. F. Panzer, a physician of Nuremberg, and a learned entomologist, born in 1755. Author of various works upon different orders of insects, published between the years 1796 and 1813; useful works of reference at the present day on account of the accuracy of the colored figures.

PAYK. Gustavus Paykull, counsellor to the King of Sweden, an able and accurate entomologist. Author of a Fauna of Sweden, 3 vols. 8vo. 1800, confined to the Coleoptera, and author of various memoirs upon insects, and also upon birds.

PECK. William Peck, Professor of Botany in Harvard University. Prof. Peck was the author of several papers upon the natural history of certain species of injurious beetles and other insects in the Mass. Agric. Repository and Journal, 1819, and elsewhere.

PUTZ. J. Putzeys, a French entomologist. Author of a monograph of Clivina and allied genera, 1846, and other memoirs.

RAND. John W. Randall, author of two papers on Coleoptera in the 2d volume of the Boston Journal of Natural History.

REAUM. R. A. Ferchault de Reaumur, one of the most eminent of the older French naturalists; born 1683, died 1757. His labors were directed to many different departments of science, but his most important work and that which makes his name familiar to the entomologists of the present day is his memoirs upon the Natural History of Insects, 6 vols. 4to, with plates, 1734-42. This admirable work is a treasury of interesting and accurate observations upon the natural history of insects, from which all subsequent authors have freely drawn.

RILEY. Charles V. Riley, State Entomologist of the State of Missouri. Author of a series of valuable illustrated annual reports upon insects, chiefly those injurious to vegetation. First report published in 1869; the sixth report published in 1874. Also joint editor with Mr. B. D. Walsh of the American Entomologist, 1868-69, which was continued by Mr. Riley after Mr. Walsh's death to December, 1870.

ROG. W. F. Rogers, of Philadelphia. Author of a synopsis of North American Chrysomelides, 1854; since deceased.

SAY. Thomas Say, a distinguished American naturalist, and founder of descriptive entomology in the United States; born 1787, died 1834. Author of the American Entomology, 1 vol. 8vo. illustrated by colored figures, executed by his wife; and of many descriptive memoirs upon North American insects in all the orders. These papers have been collected and edited by Dr. J. L. LeConte, in 2 vols. 8vo. 1859.

SCH. or SCHŒN. C. J. Schœnherr, a learned Swedish entomologist. Author of an extensive work on the synonyms of insects, in many volumes from 1806 to 1817. Also author of an elaborate work on the Genera and Species of the Curculionidæ, in which many American species were first described; one of the leading authorities in this extensive family.

SHIMER. Dr. Henry Shimer, of Mount Carroll, Illinois. Author of several papers upon Coleoptera and other insects, in the American Naturalist, and in the Trans. of the Am. Ent. Society.

SOL. M. Solier, a French entomologist. Author of several essays and memoirs upon the Coleoptera, published mostly in the annals of the Entomological Society of France, 1840-48.

STAL. C. Stäl, a Swedish entomologist. Author of a recent review of American Chrysomelides, in the Transactions of the Swedish Academy.

UHLER. P. R. Uhler, Assistant Librarian of the Peabody Institute, Baltimore. Author of descriptions of a few species of Coleoptera, but chiefly known as a writer upon the Hemiptera and Orthoptera.

WALSH. Benj. D. Walsh, State Entomologist of the State of Illinois, for the years 1868 and 1869. He died from a railroad accident on the 18th of November, 1869. Author of one official report, in 1868. Editor of the Practical Entomologist, 1865–67, and joint editor with Mr. C. V. Riley, of the American Entomologist, 1868–69; and author of various papers upon insects in scientific periodicals. Mr. Walsh was an able and enthusiastic entomologist.

WEB. Frederick Weber, a German naturalist, Professor at Kiel. Author of "Observationes Entomologicæ," 1 vol. 8vo. 1801. His name appears as the original describer of a small number of North American Coleoptera.

WESTW. J. O. Westwood. Prof. of Entomology in Oxford University, England; one of the most eminent entomologists of the present day. Author of many able works and memoirs upon insects in all the orders, many of which are illustrated by colored drawings. His most valuable work is the Introduction to the Modern Classification of Insects, in 2 vols. 8vo., pages 462 and 745, with 133 blocks of figures inserted in the text, each containing about twenty outline cuts, illustrating all the orders of insects and the details of their structure. This admirable work, which was published in 1839–40, is now out of print, and copies are difficult to be obtained.

ZIEGL. Rev. David Ziegler, author of descriptions of New Species of Coleoptera, in the Proceedings of the Acad. of Nat. Sciences, of Philadelphia, for the year 1844.

ZIMM. Christian Zimmerman, M. D., an able and accurate entomologist, who came to this country from Germany about the year 1832. He left many valuable notes upon the Coleoptera, in manuscript, but most of his descriptions of species have been superseded by more recent publications. Some of these papers have been recently published, with annotations, by Dr. LeConte, in the Transactions of the American Entomological Society, for the year 1868.

GLOSSARY,

OR DEFINITION OF THE TERMS MOST COMMONLY USED IN DESCRIBING INSECTS.

Abbreviated, shortened; not reaching the end of a given part,
Abdomen, the hindermost division of the body. See page 14.
Abnormal, irregular, exceptional.
Abrupt, sudden, not gradual.
Acicular, needle-shaped.
Aculeate, prickly.
Acute, sharp-pointed.
Adephagous, ravenous, predaceous.
Annulate, furnished with rings.
Antenna, (plural *antennæ*), appendages to the head, commonly called the horns. See page 10.
Apex, the terminal point.
Approximate, near to, or near together.
Apterous, without wings.
Articulate, divided into joints.
Attenuated, tapering.
Base, the part furthest from the apex; the base of the thorax is the part where it joins the elytra.
Bifid, cleft; cloven in two.
Bilobate, divided into two lobes.
Capitate, terminating in a little head or knob.
Carinate, furnished with a keel or ridge.
Cinereous, ash-colored.
Clavate, club-shaped, enlarged towards the end.
Claws, the pair of hooks at the end of the feet.
Clypeus, the anterior margin of the head.
Compressed, flattened laterally.
Confluent, running into one another.
Contiguous, touching each other.
Coriaceous, like leather, hard, but flexible.
Corrugated, wrinkled.
Coxa, the basal joint of the leg, (plural *coxæ*.) See pages 14 and 27.
Crenate, scalloped.
Cylindrical, long and round, of the same thickness throughout.
Decumbent, bending down.
Deflected, bent down.
Dehiscent, gaping, separated at the tips.
Dense, thickly crowded.
Dentate, furnished with acute teeth.
Depressed, flattened downwards. Compare with *compressed*.
Diffuse, spreading, not distinctly circumscribed.
Digitate, finger-like, divided like the fingers nearly to the base.
Disk, the upper middle part of a given surface.
Distant, standing considerably apart. Compare with *remote*.
Divaricate, spreading apart.

Dorsal, relating to the back.
Elliptical, elongate-oval.
Elytra, the wing-cases.
Emarginate, notched.
Entire, whole, not indented at the end or margin.
Explanate, spread out, flattened, with a broad, thin margin.
Exserted, protruded, exposed to view.
Exterior, outer, outside of.
Exuviæ the cast-off skin.
Falcate, sickle-shaped.
Fascia, a colored band, running croswise.
Fascicle, a bundle.
Femur, (plural *femora*,) the thigh. See pages 14 and 27.
Ferruginous, yellowish-red, like the rust of iron.
Filiform, thread-like, slender, and of equal thickness.
Flexuous, waving, zig-zag.
Fulvous, tawny, reddish-yellow.
Fuscous, dark grayish-brown.
Fusiform, spindle-shaped, tapering at both ends.
Geniculate, elbowed, bent abruptly.
Genus, an assemblage of species, or sometimes a single species, possessing peculiar and distinguishing organic characters.
Glabrous, smooth, without hair or down.
Granulated, covered with small grains or minute rounded elevations.
Gregarious, living in society or flocks.
Habit, in the singular number is used scientifically to express the general aspect of an insect, independently of particular characters; but in the plural, *habits*, it has the ordinary signification of manners or modes of life.
Heteromerous, having five joints in the anterior and middle tarsi, and four joints in the hind ones.
Hirsute, clothed with stiff, erect hairs.
Humerus, the anterior and outer angle of the elytra.
Hyaline, transparent.
Imago, the perfect insect, after it has passed through its preparatory transformations. See page 8.
Imbricate, lapping over like the shingles on a roof.
Immaculate, without spots.
Immarginate, without an elevated rim or margin.
Incision, the line of separation between the segments of the abdomen.
Incrassated, thickened.
Incumbent, lying upon.
Interrupted, broken, not continuous.
Involute, rolled inwards.
Irrorate, marked with minute points.
Labial palpus, the little jointed appendage attached to the labium. See pages 12 and 27.
Labium, the lower or posterior lip. See page 11.
Labrum, the upper or anterior lip. See page 11.
Lamella, a thin plate; *lamellate*. See page 11.
Larva, literally *a mask*, the state of an insect next following the egg state. See page 8.
Lateral, on the side.
Laterally, side-ways.
Lateritious, brick-colored.
Ligula, the tongue. See page 12.
Line, in measurement, the twelfth of an inch; in marking, a very narrow stripe.
Linear, long and narrow, and of equal width.
Longitudinal, lengthwise.
Lunate, half-moon shaped.
Luteous, deep yellow, like the yolk of an egg.
Macula, a colored spot.
Mandibles, the upper or anterior jaws. See pages 11 and 27.
Maxillæ, the lower or posterior jaws. See pages 11 and 27.
Maxillary palpus, the little jointed appendage attached to the maxilla. See pages 12 and 27.
Mentum, the chin.

Mesosternum, that part of the breast to which the middle legs are attached. See figure on page 27.
Metasternum, the hindermost section of the breast, to which the hind legs are attached. See figure on page 27.
Moniliform, like a string of beads.
Mucronate, terminated abruptly in an acute point.
Necrophagous, feeding on dead animals or carrion.
Normal, of the usual form, not exceptional.
Ob, prefixed to a word reverses the position.
Obcordate, inversely heart-shaped, that is, heart-shaped, with the point directed downward or backward.
Obovate, inversely egg-shaped. See *Obcordate*.
Obsolete, undeveloped, indistinct.
Obtuse, blunt.
Occiput, the hinder part of the head.
Ocelli, the single eyes. See page 5.
Oculi, the compound eyes. See page 6.
Orbicular, round and flat, applied to a surface.
Oval, somewhat egg-shaped, but with the two ends alike.
Ovate, egg-shaped, one end being narrower than the other.
Oviduct, the instrument for depositing the eggs.
Ovum, plural *ova*, an egg.
Palmate, hand-shaped, cut in about half way to the base, like the fingers of the hand.
Palpus, plural *palpi*, little jointed appendages to the mouth. See pages 12 and 27.
Parallel, having parallel sides of equal width throughout.
Parasitic, inhabiting another animal, or living at its expense.
Pectinate, comb-toothed.
Pectus, the breast.
Peduncle, a stalk or petiole.
Pedunculated, attached at the end of a peduncle.
Pentamerous, having five joints in all the tarsi.
Penultimate, the last but one.
Perfoliate, composed of transverse flattened joints, with the axis passing through the center.
Petiolated. See *pedunculated*.
Piceous, pitch-colored, reddish black.
Pilose, clothed with long flexible hairs. Compare with *hirsute*.
Poisers, or *halteres*. See page 13.
Proboscis, the sucker.
Procumbent, lying flat. Compare with *decumbent* and *incumbent*.
Prosternum, the fore part of the breast, to which the anterior legs are attached. See page 27.
Pubescent, downy, coated with almost microscopically fine hair or down.
Punctured, marked with small impressed points or dots.
Pupa, an insect in the chrysalis state, or that following the larva.
Quadrate, square-shaped or nearly so.
Remote, standing far apart.
Reniform, kidney-shaped.
Reticulate, like net-work.
Rostrum, a beak, or prolongation of the head.
Rufous, light-reddish.
Rugose, wrinkled.
Rypophagous, filth-eating.
Salient, projecting, prominent.
Saltatory, leaping.
Scrobe, the furrow on the side of the rostrum of the snout-beetles for the reception of the antennæ.
Scutellum or *Scutel*, the top of the mesothorax, forming in the Coleoptera the small triangular piece between the bases of the elytra.
Securiform, hatchet-shaped, broadly triangular.
Sericeous, clothed with a fine silken pubescence. See *Pubescent*.
Serrate, saw-toothed. See page 11.
Sessile, attached by the whole width, not pedunculate.
Seta, a bristle.
Setaceous, bristle-like, slender and tapering.

Sinus, a hollow; a rounded notch.
Sparse, scattered, opposed to *dense*.
Spinous, armed with spines.
Spiracle, a breathing pore.
Sternum, the breast, or under side of the thorax.
Stria, plural *Striæ*, an impressed or sunken line.
Striate, marked with striæ.
Sub, prefixed to a word diminishes its meaning, equivalent to *somewhat*.
Sub-clavate, somewhat or moderately club-shaped.
Sub-cortical, living under bark.
Subulate, awl-shaped.
Sulcated, grooved.
Tarsus, the jointed foot of insects. See page 14.
Tergum, the upper side of the abdomen.
Terminal, situated at the extremity.
Tessellated, chequered.
Testaceous, pale brick-colored.
Tetramerous, having four joints in all the tarsi.
Thorax, the middle division of the body.
Tibia, the shank, that part of the leg between the thigh and the tarsus.
Tomentose, clothed with matted hair.
Transverse, cross-wise.
Transversal, having the width greater than the length.
Trimerous, having three joints in all the tarsi.
Trochanter, an appendage to the base of the thigh. See page 27.
Trochantin, a small accessory or supernumerary joint sometimes interposed between the coxa and the femur, in the anterior and middle legs.
Truncate, cut off square at the tip.
Tubercle, a little swelling or prominence.
Venter, the under side of the abdomen.
Villose, or *villous*, clothed with long soft hair.
Vitta, a colored stripe running lengthwise. Compare with *fascia*.

INDEX

OF

FAMILIES, SUB-FAMILIES AND GENERA.

A

B

C

ERRATA.

Page 86, for "leafets" read "leaflets," wherever it occurs.

Page 117, for "HETEROMEROUS BARK-BEETLES" read "PARASITIC-BEETLES," in the heading.

Page 156, for "MULORCHUS" read "MOLORCHUS," in the table.

Page VIII, for "Coleopteras" read "Coleopteres," in the note.